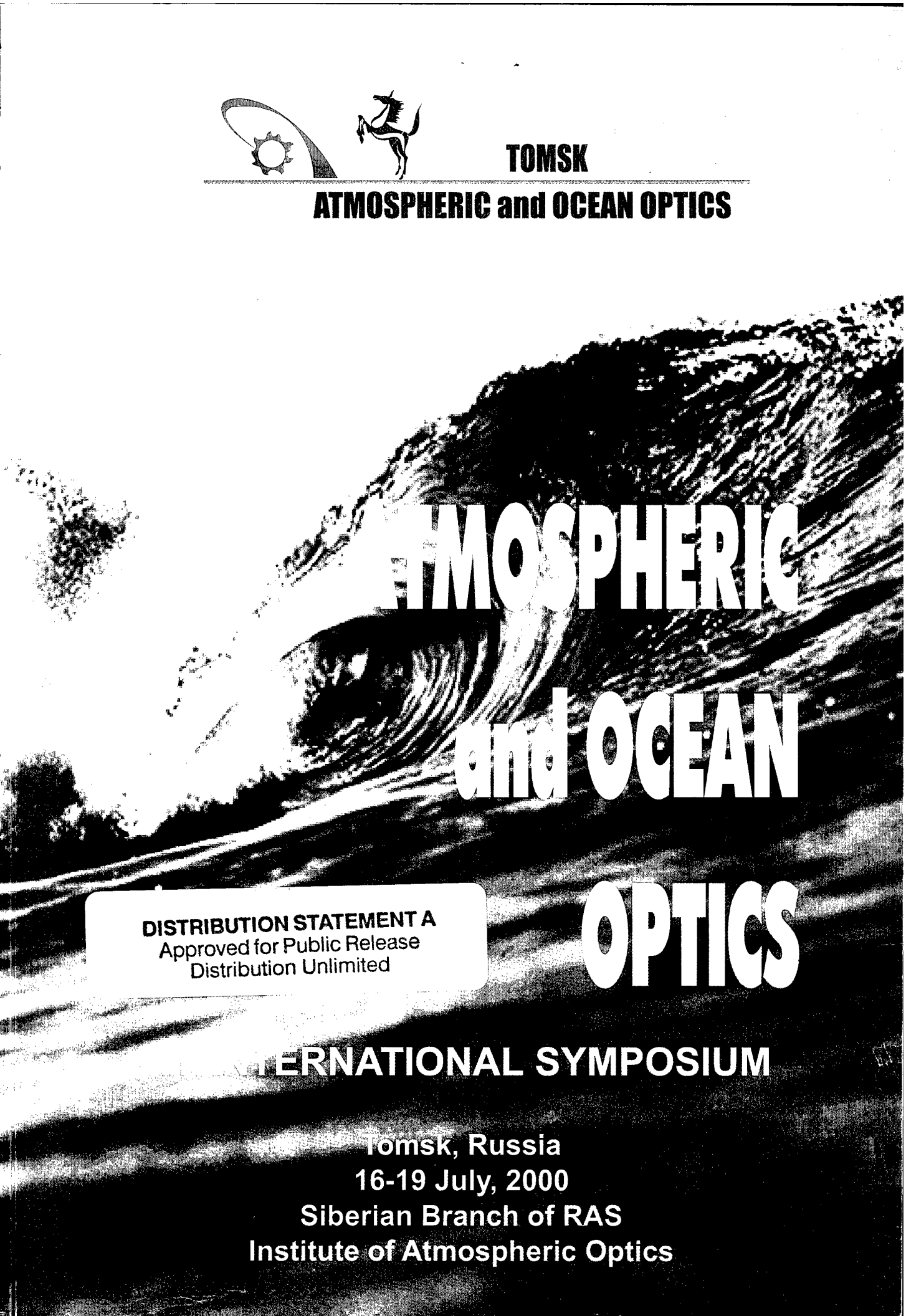
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This is an interdisciplinary conference. Topics include Atmospheric Radiative Processes, such as molecular spectroscopy of atmospheric gases; Optical Radiation Propagation in the Atmosphere, such as wave propagation in randomly inhomogeneous media; Remote Active and Passive Sounding of the Atmosphere, such as laser and acoustic sounding of the atmosphere, remote sensing studies of aerosol and gas compositon of the atmosphere.

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Institute of Atmospheric Optics

VII International Symposium on ATMOSPHERIC AND OCEAN OPTICS

TOMSK 2000
ATMOSPHERIC and OCEAN OPTICS

16 – 19 July, 2000
Tomsk, Russia

We wish to thank the following for their contribution to the success of this symposium:

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VII International Symposium on Atmospheric and Ocean Optics
Symposium Digest. Edit by M.V. Panchenko and G.P. Kokhanenko
Tomsk, Institute of Atmospheric Optics, 2000, 164 p.

Digest contains the contributions on the fundamental and applied problems of the atmospheric and ocean optics. The results of investigations on atmospheric radiative processes, optical radiation propagation in the atmosphere and ocean, remote active and passive sounding of the atmosphere and ocean, environmental optical research are discussed. The papers present the following sessions:

A1. Molecular Spectroscopy of Atmospheric Gases
A2. Radiation Absorption in the Atmosphere and Oceans, Radiative Regime, and Climatic Problems
B1. Wave Propagation in Randomly Inhomogeneous Media. Adaptive Optics
B2. Nonlinear Effects Accompanying the Radiation Propagation in the Atmosphere and Aqueous Media
C1. Multiple Scattering in Optical Sensing. Image Transfer and Interpretation
C2. Laser and Acoustic Sounding of the Atmospheric Meteorological Parameters Profiling
C3. Remote sensing studies of the Aerosol and Gas Composition of the Atmosphere and Optical Parameters of the Atmosphere and Ocean.
C4. Airborne Lidars (theoretical, model & experimental studies)
D1. Optical and Microphysical Properties of Atmospheric Aerosols
D2. Transport and Transformation of Atmospheric Aerosol and Gaseous Components
D3. Models, Databases, and Software for Solving Atmospheric Optics Problems
D4. Optical Diagnostics of the State and Evolution of Vegetative Biosystems

Abstracts were printed from the electronic forms presented by the authors. Digest is interesting for the researchers and engineers working in the areas of physics and optics of atmosphere and ocean, radiophysics, acoustics, meteorology, and ecology.

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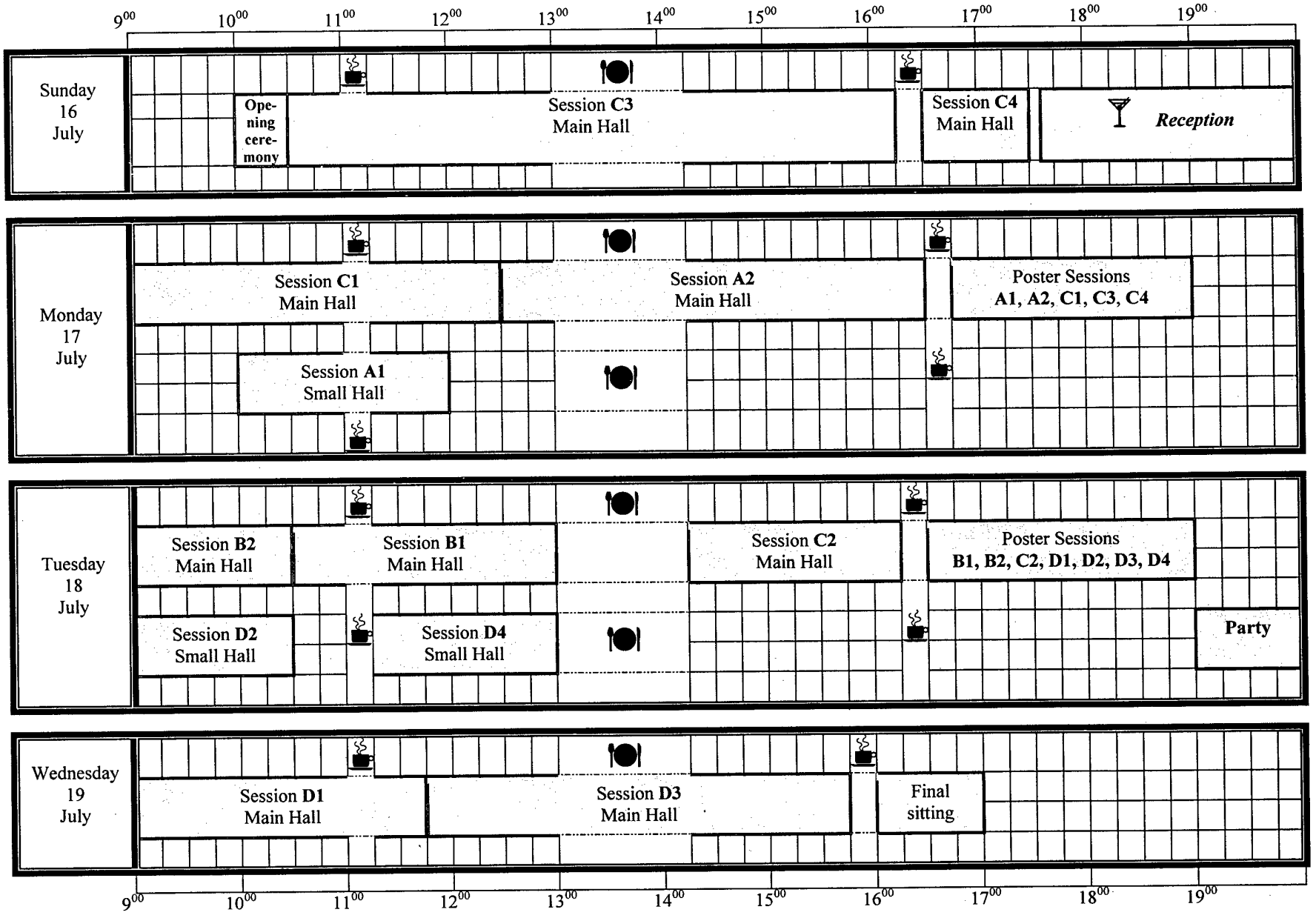
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Sunday 16 July
Ope-ning cere-mony
Session C3 Main Hall
Session C4 Main Hall
Reception
Monday 17 July
Session C1 Main Hall
Session A2 Main Hall
Poster Sessions A1, A2, C1, C3, C4
Session A1 Small Hall
Tuesday 18 July
Session B2 Main Hall
Session B1 Main Hall
Session C2 Main Hall
Poster Sessions B1, B2, C2, D1, D2, D3, D4
Session D2 Small Hall
Session D4 Small Hall
Party
Wednesday 19 July
Session D1 Main Hall
Session D3 Main Hall
Final sitting

Session: A1. Molecular Spectroscopy of Atmospheric Gases

Chair: Prof. L.N. Sinitsa

ORAL REPORTS *Monday, 17 July, 10:00–12:00. Small Hall*

10:00 STUDY OF THE H_2 EFFECTS ON O_3 CONCENTRATION IN BINARY $O_3 + H_2$ MIXTURE USING FTIR SPECTROMETRY TECHNIQUES
Barbe A., De Backer-Barilly M., Von Der Heyden P., Thomas X., Ponomarev Y.N. , Zuev V.V. **A1-01**

10:15 ABSORPTION SPECTRUM OF **HDO** MOLECULE FROM IR TO VISIBLE SPECTRAL REGIONS
Naumenko O.V., Campargue A. **A1-02**

10:30 ANOMALIES IN VIBRATIONAL SPECTRA OF INORGANIC HYDRIDES OF GROUP VA ELEMENTS IN THE CONDENSED PHASE
Nabiev Sh.Sh., Sennikov P.G., **A1-03**

10:45 COLLISIONAL INTERFERENCE OF VIBRONIC BANDS IN THE ARGON-BROADENED SPECTRUM OF **OCS**
M.R. Cherkasov **A1-04**

11:00 BREAK

11:15 AB INITIO DYNAMIC MODELS OF WEAKLY BONDED COMPLEXES IN ATMOSPHERE
Sukhanov L.P., Zheleznyakov V.V., Zamanskaya N.L., Nabiev Sh.Sh. **A1-05**

11:30 THE SOLAR RADIATION ATTENUATION BY WEAK WATER VAPOR ABSORPTION LINES IN THE NEAR INFRARED AND VISIBLE REGION
Bykov A.D., Voronin B.A., Naumenko O.V., Sinitsa L.N., Firsov K.M., Chesnokova T.Y. **A1-06**

11:45 PROBABILITY OF SIMULTANEOUS TRANSITIONS IN CO_2 WITH **HF** AND **HCL** MIXTURES
Akhmedzhanov R., Kulieva M., Khudoynazarov K., Sharifov G. **A1-07**

POSTER REPORTS *Monday, 17 July, 16:45–19:00.*

ON A DOUBLET STRUCTURE OF THE LOW-FREQUENCY IR ABSOPTION SPECTRA OF SOME AROMATIC COMPOUNDS
Demchuk Y.S., Vandyukov A.E., Vandyukov E.A. **A1-08**

GENERAL PROPERTIES OF SHORT PULSES PROPAGATION IN RELAXATION RESONANCE MEDIUM
Larichev V.A., Maksimov G.A. **A1-09**

ENERGY SHIFT IN ATOMIC AND MOLECULAR SPECTRA INDUCED BY THE BLACKBODY RADIATION FIELD
Uogintas S.R. **A1-10**

SOFTWARE PACKAGES FOR A COMPARATIVE ANALYSIS OF SPECTROSCOPIC DATABASES
Chursin A., Jacquinet-Husson N., Scott N., Chedin A., Golovko V.F. **A1-11**

THEORETICAL STUDY OF H-BOND COMPLEXES ELECTRONIC SPECTRA
Zvereva N.A. **A1-12**

ENHANCEMENT OF THE FLUORESCENT METHOD PRECISION OF THE IODINE-129 DETECTION IN AIR
Shnyrev S.L., Kireev S.V. **A1-13**

COLLISIONAL PREDISSOCIATION, VIBRATIONAL RELAXATION AND COLLISIONAL BROADENING OF THE LEVELS OF THE B STATE IN I_2 EXCITED BY 633-nm RADIATION OF A **HE-NE** LASER
Kireev S.V., Shnyrev S.L. **A1-14**

ANALYSIS OF WATER VAPOR ABSORPTION SPECTRUM IN $5\nu+\delta$ REGION
Vorob'eva L.P., Bykov A.D., Naumenko O.V. **A1-15**

SOME FEATURES OF THE *LINE-BY-LINE* TECHNIQUE FOR THE SPECTRA CALCULATIONS OF H_2O AND MOLECULAR COMPLEXES WITH H2O IN A REAL ATMOSPHERE
Fomin B.A., Zhitnitzkii E.A., Nabiev S.S. A1-16

TECHNICUE FOR STUDY OF VIBRATIONAL-TRANSLATION RELAXATION IN MOLECULE GASES USING SPECTROPHONE
Tikhomirov B.A., Tikhomirov A.B. A1-17

ON SPECTRAL LINE SHAPE IN THE 4.3 MICRON CO_2 BAND
Nesmelova L.I., Rodimova O.B., Tvorogov S.D. A1-18

SHIFTS OF THE $NU_2 + NU_3$ BAND OF H_2O DOUBLET LINES, INDUCED BY N_2 ,O_2, AR AND HE PRESSURE
Solodov A.M. A1-19

THE HDO ABSORPTION SPECTRA ANALISIS IN 6000–7000 cm^{-1}
Naumenko O.V., Bykov A.D., Voronin B.A., Sinitsa L.N., Winnewisser B.P., Winnewisser M. A1-20

EFFECTIVE HAMILTONIAN FOR VIBRONIC COUPLING ANALYSIS IN CH_2
Bykov A.D., Mikhaylov V.M., Petrova T.M. A1-21

THE INTRACAVITY LASER SPECTROMETER FOR PLASMA ABSORPTION ANALYSIS
Petrova T.M., Poplavskii Y.A., Sokovikov V.G. A1-22

ANALYSIS OF THE VIBRATIONAL DEPENDENCE OF THE SHIFTS AND HALF-WIDTHS OF SPECTRAL LINES
Stroinova V.N. A1-23

COMPARATIVE ANALYSIS FOR DETERMINATION OF FOURIER-TRANSFORM SPECTROMETER APPARATUS FUNCTION
Kochanov V.P., Savelyev V.N. A1-24

REMESUREMENTS OF N_2 BROADENING OF RESOLVED AND UNRESOLVED DOUBLETS IN THE H_2O (010)–(000) BAND
Kochanov V.P., Savelyev V.N. A1-25

WATER VAPOR ABSORPTION SPECTRUM BETWEEN 13500–13700 cm^{-1}
Tyryshkin I.S., Ponomarev Y.N., Savelyev V.N., Bykov A.D., Voronin B.A., Sinitsa L.N. A1-26

CH_4 R3 LINE OF $2N_3$ BAND BROADENING AND SHIFT MEASUREMENTS
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STUDY OF VIBRATION-TRANSLATIONAL RELAXATION OF MOLECULES O_3 (N_3) IN BINARY MIXTURES WITH MOLECULAR AND INERT GASES
Zeninari V., Courtois D., Ponomarev Y.N., Tikhomirov A.B., Tikhomirov B.A. A1-28

WATER VAPOR HOT BANDS IN 1.9 μm REGION
Sulakshina O.N., Borkov Yu.G. A1-29

INTERPRETATION OF HEATED WATER VAPOUR SPECTRA BASED ON THE INFORMATION SYSTEM HOTGAS
Bimatov M.V., Voitzekhovskaya O.K., Sheludyakov T.Yu. A1-30

DETECTION OF NONCLASSICAL LIGHT IN REMOTE SPECTROMETER SCHEME
Zhiliba A.I., Gorbachev V.N. A1-31

WEAK H-BOND COMPLEXES
Zvereva N.A., Nabiev S.S., Ponomarev Y.N. A1-32

INTERFERENCE OF WATER VAPOR LINES. CONNECTION OF INTRAMOLECULAR AND INTERMOLECULAR EFFECTS
Bykov A.D., Lavrentyeva N.N., Sinitsa L.N., Solodov A.M., Cherkasov M.R. A1-33

ON THE VIBRATIONAL DEPENDENCE OF MEAN POLARIZABILITY, HALF-WIDTHS AND SHIFTS FOR QUASIRIGID MOLECULES
Mikhailov V.M., Stroinova V.N. A1-34

ON THE ANALYTICAL PROPERTIES OF CENTRIFUGAL DISTORTION DIPOLE MOMENTS OF METHANE
Mikhailov V.M., Smirnov M.A. **A1-35**

CYBERNETICS METHODS IN SPECTROSCOPY. AUTOMATIC FIND AND FIT OF LINES OF MOLECULAR SPECTRA
Pshenichnicov A.M., Shcherbakov A.P. **A1-36**

ON THE EVALUATION AND ASYMPTOTIC BEHAVIOUR OF HERMAN–WALLIS FACTORS FOR MULTIQUANTUM VIBRATIONAL TRANSITIONS IN SYMMETRIC TOP MOLECULES
V.M. Mikhailov, E.I. Lobodenko **A1-37**

Session: A2. Radiation Absorption in the Atmosphere and Oceans, Radiative Regime, and Climatic Problems

Co-Chairs: Prof. S.D. Tvorogov, Prof. M.V. Kabanov

INVITED SPEAKER *Monday, 17 July, 12:30. Main Hall*

12:30 SPATIAL-TEMPORAL VARIABILITY OF THE TEMPERATURE REGIME OF SIBERIA
Kabanov M.V., Zadde G.O., Ippolitov I.I., Kataev S.G., Kuskov A.I. **A2-01**

13:00 LUNCH

ORAL REPORTS *Monday, 17 July, 14:15–16:30. Main Hall*

14:15 EFFECT OF ICE CRYSTALS' SHAPE AND SIZE ON RADIATION CHARACTERISTICS OF CLOUDS
Zhuravleva T.B., Petrushin A.G. **A2-02**

14:30 THE METHOD OF AEROSOL OPTICAL THICKNESS SEPARATION INTO ABSORPTION AND SCATTERING COMPONENTS
Pavlov V.E., Pashnev V.V., Pushkina N.G., Korovchenko V.N. **A2-03**

14:45 THE INFLUENCE OF SOLAR RADIATION ON CHANGING THE SURFACE OZONE CONCENTRATION
Sklyadneva T.K., Belan B.D., Smirnov S.V. **A2-04**

15:00 LONG-TERM VARIABILITY OF THE GLOBAL OZONE LAYER
Kruchenitzkii G.M., Borisov Yu.A., Chernikov A.A., Perov S.P., Zvyagintzev A.M. **A2-05**

15:15 MODELLING OF THE OZONE VERTICAL DISTRIBUTION
Kruchenitzkii G.M. **A2-06**

15:30 INFLUENCE OF VARIABILITY OF CH_4, N_2O, AND FREON CONCENTRATIONS ON LONGWAVE RADIATION FLUXES IN THE EARTH'S ATMOSPHERE
Firsov K.M., Ponomarev Y.N., Chesnokova T.Y. **A2-07**

15:45 TRANSMITTANCE PARAMETRIZATION IN THE EARTH ATMOSFHERE RADIATION TRANSFER PROBLEMS
Mitsel A.A., Firsov K.M. **A2-08**

16:00 FORWARD MODEL AND RETRIEVAL ALGORITHM DEDICATED TO NADIR AND LIMB VIEWING MEASUREMENTS. COMPARISON WITH THE *LINE-BY-LINE* LPMA ALGORITHM
Eremenko M.N., Payan S., Camy-Peyret C., Kataev M.Y., Mitsel A.A. **A2-09**

16:15 THEORETICAL AND EXPERIMENTAL ANALYSIS OF OPTICAL ABSORPTION SPECTRA OF ALGAE (ON EXAMPLE OF *SPIRULINA PLATENSIS*)
Abdulkin V.V., Paramonov L.E., Chrometchek E.B. **A2-10**

POSTER REPORTS *Monday, 17 July, 16:45–19:00.*

A NUMERICAL MODEL OF THE DAYLIGHT SKY BRIGHTNESS FIELD FOR THE ATMOSPHERE HOMOGENEOUS IN LAYERS
Morozov A.M. **A2-29**

IDENTIFICATION OF CLOUD PHASE COMPOSITION TEST WITHIN ICE AND WATER ABSORPTION BANDS
Goryachev B.V., Mogilnitskii S.B., Kabanov M.V. **A2-30**

SOME OF PECULIARITIES OF THE RADIATIVE TRANSFER IN RERADIATION MEDIA
Goryachev B.V., Mogilnitskii S.B. **A2-31**

APPROXIMATE METHOD FOR GAS TRANSMITTANCE CALCULATION
Zolotov S.Yu., Mitsel A.A. **A2-32**

THE LAW OF CHANGE OF CAPACITY OF A DOZE OF γ-RADIATION FROM LOCAL RADIOACTIVE - POLLUTES OF A SITE OF DISTRICT DEPENDING ON HEIGHT OF A POINT OF MEASUREMENT
Khomyakov N.N. **A2-33**

ZONATION RADIOACTIVE-POLLUTES DISTRICTS AT THE INITIATED DESTRUCTION ATOMIC POWER STATION
Khomyakov N.N., Khomyakov D.N. **A2-34**

Session: B1. Wave Propagation in Randomly Inhomogeneous Media. Adaptive Optics

Chair: Prof. V.P. Lukin

ORAL REPORTS *Tuesday, 18 July, 10:30–13:00. Main Hall*

10:30 RADIATION INTENSITY FLUCTUATIONS ON LONG PATH IN ABSORBING TURBULENT ATMOSPHERE
Suvorov A.A., Almaev R.Kh. **B1-01**

10:45 TRACKING SENSORS FOR ADAPTIVE OPTICS
Tartakovskii V.A. **B1-02**

11:00 BREAK

11:15 PHASE RECONSTRUCTION OF THE OPTICAL SPECKLE FIELD
Aksenov V.P., Tikhomirova O.V. **B1-03**

11:30 METEREOLOGICAL ASPECTS OF THE SITE TESTING OF MOUNT MAIDANAK
Igamberdieva R.Z., Ilyasov S.P. **B1-04**

11:45 AUTOMATIC DEVICE FOR MEASUREMENT OF FLUCTUATIONS OF ABSOLUTE HUMIDITY
Rostov A.P., Afanas'ev A.L. **B1-05**

12:00 OPPORTUNITIES AND LIMITATIONS OF MULTIREFERENCE ADAPTIVE OPTICS
Yaitskova N.A., Shmalgausen V.I. **B1-06**

12:15 LASER REFERENCE CROOS AS A TOOL FOR TILT PROBLEM RESOLVING
Lukin V.P. **B1-07**

12:30 CORRECTION OF MODES IN WAVE FRONT, CAN BE PROCESSED BY ADAPTIVE OPTICAL SYSTEM
Chernyavskii S.M. **B1-08**

12:45 FIRST-ORDER ADAPTIVE SYSTEM FOR CORRECTION OF IMAGES IN SOLAR GROUND-BASED TELESCOPES
Lukin V.P., Antoshkin L.V., Botygina N.N., Emaleev O.N., Petrov A.I., Lavrinova L.N., Fortes B.V., Yankov A.P., Grigoriev V.M., Borovik A.V., Bulatov A.V., Kovadlo P.G., Skomorovskii V.I., Firstova N.M. **B1-09**

POSTER REPORTS *Tuesday, 18 July, 16:30–19:00*

ADAPTIVE CONTROL WITH RAY FLOWS OF MULTIBEAM LASER
Voronov V.I., Trofimov V.V. **B1-10**

THE EFFICIENCY ANALYSIS OF WAVEFRONT RECONSTRUCTION ALGORITHM BY SMOOTHING SPLINES IN CASE OF NOISES IN CHANNELS OF ADAPTIVE OPTICAL SYSTEMS
Sklyarov A.D., Bezuglov D.A. **B1-11**

LIGHT DIFFRACTION AT CAPILLARY WAVES
Kolomiets S.M. **B1-12**

A COMPARISON OF THE SEEING MEASUREMENTS AT mt. MAIDANAK FOR PERIOD 1968–2000
Baizhumanov A.K., Ilyasov S.P. **B1-13**

TRANSFER OF NONCLASSICAL LIGHT IN LINEAR MEDIUM
Zhiliba A.I., Gorbachev V.N. **B1-14**

AMPLITUDE FLUCTUATIONS OF SOUND WAVE PROPAGATING OVER THE GROUND SURFACE IN THE ATMOSPHERE
Bochkarev N.N. **B1-15**

GENERAL MODE AND TOPOLOGICAL PROPERTIES OF BESSEL BEAMS. VECTOR SOLUTIONS
Zhilaitis V.Z. **B1-16**

CORRELATION OF CLOUDINESS RADIATION FLUCTUATIONS IN THE RANGE OF 3–5 AND 8–13 μm
Allenov A.M., Ivanova N.P., Ovchinnikov V.V. **B1-17**

STABILIZATION OF SOLAR DISK IMAGE FRAGMENT ON SPECTROGRAPH ENTRANCE SLIT
Botygina N.N., Antoshkin L.V., Emaleev O.N., Lavrinova L.N., Lukin V.P., Petrov A.I., Fortes B.V., Yankov A.P. **B1-18**

DISTRIBUTED COMPONENT OBJECT AS A MODEL OF ADAPTIVE OPTICAL SYSTEM
Kanev F.Yu, Lavrinova L.N. **B1-19**

REPRESENTATION OF PHASE OF DISTORTED OPTICAL WAVE IN THE ORTHONORMAL BASES FOR TWO MODELS OF TURBULENCE. SIMULATION
Zakharova E.V., Isaev Yu.N. **B1-20**

INFLUENCE OF FLUCTUATIONS OF A VELOCITY OF A WIND FOR A SPATIALLY - TEMPORARY STRUC-TURE FUNCTION OF FLUCTUATIONS OF A PHASE OF AN OPTICAL WAVE IN TURBULENT ATMOSPHERE
Lukin I.P. **B1-21**

LASER BEAM PROPAGATION IN A TURBULENT ATMOSPHERE, TAKING INTO ACCOUNT FLUCTUATION OF IMPURITY CONCENTRATIONS
Baranov V.Yu., Petrushevich Yu.V., Svotin P.A., Starostin A.N. **B1-22**

SPECTRA OF SHIFT OF THE IMAGE OF A SOURCE ON THE CORRELATED AND UNCORRELATED PATHS
Sazanovich V.M., Tsvyk R.S. **B1-23**

FLUCTUATION CHARACTERISTICS OF LASER RADIATION IN SNOWFALL
Vostretsov N.A., Zhukov A.F. **B1-24**

FLUCTUATION CHARACTERISTIC OF LASER RADIATION SCATTERED FROM A FOCUSED LASER BEAM
Vostretsov N.A., Zhukov A.F. **B1-25**

THE RELATIVE CONTRIBUTIONS OF VARIOUS LAYERS OF A TURBULENCE OF ATMOSPHERE TO A FLUCTUATION OF ASTRONOMICAL IMAGES
Lukin I.P. **B1-26**

PECULIARITIES OF THE MEAN ANNUAL VARIATION OF THE SCATTERED SOLAR RADIATION AT CLEAR SKY IN THE FORMER USSR
Kovadlo P.G. **B1-27**

2D-POLYNOMIAL MODEL OF OPTICAL VORTICES CREATION AND ANNIHILATION
Sennikov V.A., Tartakovskii V.A. **B1-28**

ON THE PROBLEM OF PHASE DISTORTION CORRECTION BY THE NEWTON MODIFIED METHOD IN THE ADAPTIVE OPTICAL SYSTEM
Chernyavskii S.M., Degtyarev G.L., Makhan'ko A.V., Chernyavskii A.S. **B1-29**

THE MEASUREMENTS OF THE ATMOSPHERIC PARAMETERS AT mt. MAIDANAK FOR OBSERVATIONS WITH HIGH ANGULAR RESOLUTION
Ilyasov S.P., Tokovinin A.A., Kornilov V.G., Ziad A., Egamberdiyev S.A., Tillayev Y.A., Sarazin M., Sultanov K.B. **B1-30**

ROPAGATION OF LOCATION SIGNAL IN ABSORBING RANDOM MEDIUM WITH LENS PROPERTIES
Suvorov A.A., Almaev R.Kh. **B1-31**

ENERGY STREAM-LINES UNDER THE CONDITIONS OF FORMING THE OPTICAL VORTICES
Aksenov V.P., Izmailov I.V., Poizner B.N., Tikhomirova O.V. **B1-32**

ON THE HIGH ALTITUDE WIND VELOCITY ABOVE THE mt. MAIDANAK
Ilyasov S.P., Tillayev Y.A. **B1-33**

DEEP-WATER AUTOMATIC MULTI CHANNEL ACCELEROMETER OF A WATER TRANSPARENCY
Rostov A.P., Kokhanenko G.P., Matyushenko V.A. , Sherstyankin P.P. , Khokhlov V.V. **B1-34**

ANALYSIS OF LASER RADIATION ABSORPTION FOR VARIOUS ATMOSPHERIC PATHS ON THE BASIS OF THE EXPERIMENTAL DATA ON THE SPECTRAL COMPOSITION OF MOST TYPICAL CHEMICAL LASERS
Filimonova V.A. **B1-35**

Session: B2. Nonlinear Effects Accompanying the Radiation Propagation in the Atmosphere and Aqueous Media

Chair: Prof. A.A.Zemlyanov

ORAL REPORTS *Tuesday, 18 July, 9:00–10:30. Main Hall*

9:00 THE INTERACTION OF INTENSE LASER RADIATION WITH A CARBON AEROSOL PARTICLE AT ARBITRARY AIR HUMIDITY
Apasov S.M., Kaplinskii A.E. **B2-01**

9:15 ACCOUNT OF AN OPTICAL BEAM SPREADING CAUSED BY TURBULENCE FOR THE PROBLEM OF PARTIALLY COHERENT PROPAGATION THROUGH INHOMOGENEOUS ABSORBING MEDIA
Dudorov V.V., Kolosov V.V. **B2-02**

9:30 DYNAMIC LIGHT SCATTERING ON STIMULATED PONDEROMOTIVE VIBRATIONS OF POLYDISPERS AEROSOL DROPLETS
Zemlyanov A.A., Geintz Y.E., Palchikov A.V. **B2-03**

9:45 EFFICIENCY OF OPTICAL FIELDS INTERACTION AT UNELASTIC LIGHT SCATTERING PROCESSES IN SPHERICAL MICRORESONATORS
Panina E.K., Geintz Y.E., Zemlyanov A.A. **B2-04**

10:00 NONLINEAR EFFECTS AT ABSORBTION OF LASER RADIATION BY WATER MEDIA, CONTAINING PHENOLS
Svetlichny V.A., Sokolova I.V., Chaikovskaya O.N., Kopylova T.N., Kuznetsova R.T., Meshalkin Yu.P. **B2-05**

10:15 TWO-PHOTON EXCITED LUMINESCENCE IN DYE DROPS
Donchenko V.A., Zemlyanov Al.A., Zemlyanov A.A., Kibitkin P.V. **B2-06**

POSTER REPORTS *Tuesday, 18 July, 16:30–19:00.*

HIGH INTENSITY OPTICAL EFFECTS USING MILLIWATT LASERS
Armstrong R.L., Kim W.T., Shalaev V.M., Drachev V. **B2-07**

THE RESULTS OF EXPLORATION PROBABLE STRUCTURE OF SEISMOGENEOUS PERTURBATIONS SEISMOACTIVE REGIONS BEFORE STRONG EARTHQUAKES
Tertyshnikov A.V., Akselevich V.I. **B2-08**

GENERATION OF ACOUSTIC PULSES ON THE NATURAL CENTERS OF ABSORPTION WITH DISTRIBUTION CO_2 LASER ON ATMOSPHERIC PATHS
Bochkarev N.N., Kabanov A.M., Pogodaev V.A. **B2-09**

THE CHARACTERISTICS OF THE OPTICAL AND ACOUSTIC RESPONSE WITH VARIOUS REGIMES OF NONLINEAR INTERACTION OF LASER RADIATION WITH AN ABSORBING AEROSOL PARTICLE
Bochkarev N.N., Kabanov A.M., Pogodaev V.A. **B2-10**

THERMOCAPILLARITY MECHANISM OF LASER BEAM SELF-ACTION IN TWO-COMPONENT MEDIUM
Ivanov V.I., Karpetz Yu.M. **B2-11**

ERROR OF THE RAY-TRACING TECHNIQUE FOR A PROPAGATION PROBLEM OF A PARTIALLY COHERENT RADIATION THROUGH INHOMOGENEOUS MEDIA
Dudorov V.V., Kolosov V.V. **B2-12**

PARAMETERS OF SITES OPTICAL BREAKDOWN OF AIR BY RADIATING POWERFUL CO_2 LAZER
Shishigin S.A., Kokhanov V.I. **B2-13**

OPTO-ACOUSTIC EFFECTS ACCOMPANYING A LASER-INDUCED BREAKDOWN ON THE MONODISPERSE SOLID AEROSOL PARTICLES
Shamanaev S.V. **B2-14**

STATISTICAL ANALYSIS OF SPECTRA OF ACOUSTIC SIGNALS IN LASER BREAKDOWN INITIATED ON THE MONODISPERSE SOLID AEROSOL PARTICLES
Shamanaev S.V. **B2-15**

DECREASE OF THE THRESHOLDS OF NON–LINEAR OPTICAL EFFECTS IN BIG DROPS AT DIFFERENT GEOMETRY OF EXCITATION
Donchenko V.A., Zemlyanov Al.A., Zemlyanov D.A., Kibitkin P.V., Geintz Y.E. **B2-16**

Session: C1. Multiple Scattering in Optical Sensing. Image Transfer and Interpretation

Co-Chairs: Prof. V.V. Belov, Prof. B.A. Kargin

INVITED SPEAKERS: *Monday, 17 July, 9:00–10:00. Main Hall*

9:00 A HIERARCHY OF MODELS FOR LIDAR MULTIPLE SCATTERING AND ITS APPLICATION FOR SIMULATION AND ANALYSIS OF SPACE-BASED LIDAR RETURNS
Oppel U.G. **C1-01**

9:30 STATISTICAL MODELLING OF STOCHASTIC PROBLEMS OF THE ATMOSPHERE AND OCEAN OPTICS
Kargin B.A. **C1-02**

ORAL REPORTS *Monday, 17 July, 10:00–12:30. Main Hall*

10:00 REMOTE SENSING OF HIGH-TEMPERATURE OBJECTS ON THE UNDERLYING SURFACE FROM NOAA SATELLITES: POSSIBILITIES, PROBLEMS, AND RESULTS
Belov V.V., Afonin S.V., Gridnev Y.V. **C1-03**

10:15 USE OF LONG-TERM PREDICTION IN AUTOMATIC VERTICAL-INCIDENCE IONOGRAM PROCESSING
Grozov V.P., Kotovich G.V., Nosov V.E. **C1-04**

10:30 ADAPTIVE DECONVOLUTION OF BLURRED IMAGES BASED ON AN ANALYSIS OF THE TEXTURE CHARACTERISTICS OF VIDEODATA
Protasov K.T., Belov V.V., Molchunov N.V. **C1-05**

10:45 MODELING OF TRANSFER CHARACTERISTICS OF ATMOSPHERIC-OPTICAL CHANNELS IN ACTIVE IMAGING SYSTEMS
Belov V.V., Borisov B.D. **C1-06**

11:00 BREAK

11:15 DETECTION OF THE FOREST FIRES
Telpukhovskii E.D., Karpov S.N., Yakubov V.P., Skugarev A.A. **C1-07**

11:30 SINGULAR APPROXIMATION IN IMAGE COMPRESSION
Yakubov V.P. **C1-08**

11:45 RATING OF OPPORTUNITIES CLASSIFICATION OF SATELLITE MEASUREMENTS MID-ELEVATION TAIGA REGIONS
Zagorul'ko V.A., Khamarin V.I., Platonova N.A. **C1-09**

12:00 APPLICATION OF DIGITAL FILTRATION TO THE DYNAMIC IMAGES OF AEROSOL PLUMES
Dmitriev B.N., Sutorikhin I.A. **C1-10**

12:15 SEPARATION OF COMPONENTS IN ASYMPTOTIC ESTIMATES OF LIDAR SIGNALS WITH CONSIDERATION OF MULTIPLE SCATTERING IN THE SMALL-ANGLE APPROXIMATION
Veretennikov V.V. **C1-11**

POSTER REPORTS *Monday, 17 July, 16:45–19:00.*

ESTIMATION OF DIFFERENT EXPERIMENTAL CONFIGURATIONS TO SOUND A DEEP INHOMOGENEITY IN A TRANSLUCENT MEDIUM
Barun V.V. **C1-12**

A LIDAR WITH CHANGEABLE FIELD OF VIEW FOR RECORDING MULTIPLE SCATTERING
Abramochkin A.I., Abramochkin S.A., Bryukhanova V.V., Samokhvalov I.V., Tikhomirov A.A. **C1-13**

CONSIDERATION OF A PRIORI INFORMATION FOR THE RECOGNITION OF DOMINANT SPECIES OF TAIGA FORESTS FORM SATELLITE VIDEODATA
Khamarin V.I., Serykh A.P., Protasov K.T. **C1-14**

ON THE STATISTICAL METHODS OF THE PROCESSING THE SPACE SEA SURFACE IMAGES
Sklyarov V.E. **C1-15**

SISTEM OF ORTOGONAL BASE FUNCTIONS FOR SOLUTION OF THE NONSTATIONARE RADIATIVE TRANSFER"S EQUATION
Gavrilovich A.B. **C1-16**

DEVELOPMENT OF MATEMATICAL MODEL 0F TRANSFER AND POLARISATION OF SUN RADIATION IN THE ATMOSPHERE – OCEAN SPHERICAL SYSTEM FOR PROBLEMS OF REMOTE MEDIUM DIAGNOSTICS
Gavrilovich A.B. **C1-17**

THE INFLUENCE FUNCTIONS AND THE SOLUTIONS OF THE ADJOINT EQUATIONS IN THE THEORY OF THE OPTICAL TRANSFER OPERATOR
Sushkevich T.A., Kulikov A.K., Maksakova S.V., Strelkov S.A. **C1-18**

THE LINEARLY-SYSTEM APPROACH AND THE THEORY OF THE OPTICAL TRANSFER OPERATOR IN THE CASE OF THE ANISOTROPICALLY REFLECTING UNDERLYING SURFACE
Sushkevich T.A., Kulikov A.K., Maksakova S.V., Strelkov S.A. **C1-19**

ATMOSPHERIC OPTICAL PROPERTIES MEASUREMENTS IN INVERSE PROBLEMS FOR THE PROCESSING OF MULTISPECTRAL SATELLITE DATA
Shlyakhova L.A., Povkh V.I., Kozoderov V.V. **C1-20**

RECONSTRUCTION OF BINARY IMAGES IN OPTICAL INFORMATION SYSTEMS OF REMOTE MONITORING
Borisov B.D., Belov V.V., Gridnev Y.V. **C1-21**

SEPARATION OF COMPONENTS IN ASYMPTOTIC ESTIMATES OF LIDAR SIGNALS WITH CONSIDERATION OF MULTIPLE SCATTERING IN THE SMALL-ANGLE APPROXIMATION
Veretennikov V.V. **C1-22**

EFFECTIVE ALGORITHM TO COMPUTE POLARIZED RADIATION TRANSFER IN THE ATMOSPHERE – OCEAN AND ATMOSPHERE – EARTH SYSTEMS
Katsev I.L., Prikhach A.S., Chaikovskaya L.I., Zege E.P. **C1-23**

COMPARISON OF IMAGE QUALITY OF UNDERWATER OBJECT AND ITS SHADOW IN AIRBORNE PULSE VISION SYSTEM
Katsev I.L., Zege E.P., Prikhach A.S. **C1-24**

APROXIMATION OF ENERGY DENSITY SCATTERING RADIATION BY CLOUD
Wagin N.I., Trofimov E.L. **C1-25**

STUDY OF VERTICAL COMPONENT OF A TURBULENT DIFFUSION COEFFICIENT USING THE IMAGE ANALYSIS OF AEROSOL PLUMES
Dmitriev B.N., Sutorikhin I.A. **C1-26**

NUMERICAL ESTIMATES OF INFLUENCE OF SOME MODELS OF THE STOCHASTIC MEDIUM TO THE RADIATION TRANSPORT
Lavrentyev A.E., Kargin B.A. **C1-27**

EVALUATION OF EFFICIENCY OF SATELLITE MONITORING OF FOREST FIRES UNDER DAYTIME AND NIGHTTIME CONDITIONS IN THE PRESENCE OF BROKEN CLOUDS
Astafurov V.G. **C1-28**

DETECTION OF FIRES FROM SATELLITE IMAGES USING A NONPARAMETRIC ALGORITHM OF PATTERN RECOGNITION IN SPACE OF THE INFORMATIVE PARAMETERS
Pushkareva T.G., Protasov K.T. **C1-29**

INTEGRATED CORRECTION OF IMAGES RECORDED WITH THE AVHRR INSTRUMENT USED ONBOARD NOAA SATELLITES EMPLOYED FOR RESOURCE-ECOLOGICAL MONITORING
Artamonov E.S., Protasov K.T. **C1-30**

ESTIMATION OF THE SPATIOTEMPORAL STRUCTURE OF LIDAR RETURN SIGNALS CORRESPONDING TO DIFFERENT MULTIPLICITIES OF RADIATION SCATTERING IN A MEDIUM
Serebrennikov A.B., Belov V.V. **C1-31**

Session: C2. Laser and Acoustic Sounding of the Atmospheric Meteorological Parameters Profiling

Co-Chairs: Prof. V.A. Banakh, Dr. A. Kohnle

INVITED SPEAKER *Tuesday, 18 July, 14:15. Main Hall*

14:15 ATMOSPHERIC EFFECTS ON IR-SENSOR PERFORMANCE: THEORY AND RECENT EXPERIMENTAL RESULTS
Kohnle A., Stein K., Weiss-Wrana K. **C2-01**

ORAL REPORTS *Tuesday, 18 July, 14:45–16:15. Main Hall*

14:45 LIDAR STUDY OF TEMPERATURE REGIME IN THE STRATOSPHERE OVER TOMSK
Marichev V.N., Zuev V.V., Nevsorov A.V., Khryapov P.A. **C2-02**

15:00 EFFECT OF REFRACTIVE TURBULENCE ON TEMPORAL SPECTRUM OF WIND VELOCITY MEASURED WITH A CW DOPPLER LIDAR
Banakh V.A., Werner X., Smalikho I.N. **C2-03**

15:15 DIFFERENTIAL LIDAR SYSTEMS: PHASE PECULARITIES OF BEATING SIGNAL
Il'in G.L, Morozov O.G., Tzareva M.A. **C2-04**

15:30 PARAMETRIC STATISTICAL ANALYSIS OF DATA WITH AEROSOL MICRO PULSE LIDAR (MPL)
Razenkov I.A., Cha H.K., Kim D.H., Shefer N.A. **C2-05**

15:45 INTERPRETATION OF THE DATA OF SIMULTANEOUS SODAR MEASUREMENTS OF VERTICAL PROFILES OF C_T^2 AND C_V^2 IN THE ATMOSPHERIC BOUNDARY LAYER
Shamanaeva L.G. **C2-06**

16:00 RESULTS OF SIMULTANEOUS MEASUREMENTS OF WIND VELOCITY FIELD BY ACOUSTIC LOCATOR AND ULTRASONIC ANEMOMETER IN A STEPPE REGION
Bogushevich A.Y., Gladkikh V.A., Makienko A.E., Fedorov V.A. **C2-07**

POSTER REPORTS *Tuesday, 18 July, 16:30–19:00*

STUDY OF MULTI-DAYS CYCLES OF CHANGES THE COMPONENTS OF TURBULENT DIFFUSION COEFFICIENTS TENSOR IN THE ATMOSPHERIC GROUND-LEVEL
Borodulin A.I., Lapteva N.A., Marchenko V.V., Shabanov A.N. **C2-08**

VERTICAL PROFILES OF THE OUTER SCALE OF ATMOSPHERIC TURBULENCE IN THE ATMOSPHERIC BOUNDARY LAYER FROM THE DATA OF ACOUSTIC SOUNDING
Shamanaeva L.G. **C2-09**

LIDAR MEASUREMENTS OF METEOR TRACES PARAMETERS
Tashenov B.T., Filippov V.A., Lyadzhin V.A., Filippov R.V. **C2-10**

OPTICAL BASIS METHOD FOR ATMOSPHERE HUMIDITY CONTROL, DISTURBING FACTORS STABLE
Kugeiko M.M., Figaro V.A., Kapora S.M. **C2-11**

CLOUDS VELOCITY MEASURING SYSTEM FOR LIDAR COMPLEXES
Il'in G.I., Il'in A.G., Khairullin N.G., Loginov V.I. **C2-12**

USE OF SODAR "VOLNA-3" FOR MEASURING WIND VELOCITY FIELD MOMENTS AND ESTIMATING THEIR ERRORS.
Fedorov V.A. **C2-13**

APPLICATION OF PARAMETRICAL STATISTICS FOR THE ANALYSIS OF DATA OF METEOROLOGICAL FIELDS IN THE SURFACE LAYER OF THE ATMOSPHERE
Afanas'ev A.L., Razenkov I.A., Shefer N.A., Rostov A.P. **C2-14**

PRELIMINARY RESULTS OF "VOLNA-3" SODAR MEASUREMENTS OF ALTITUDE PROFILES OF STANDARD DEVIATIONS, SKEWNESS, AND KURTOSIS OF HORIZONTAL WIND SPEED AND DIRECTION
Gladkikh V.A., Makienko A.E., Fedorov V.A. **C2-15**

MEASUREMENT OF TURBULENT FLUCTUATIONS OF HUMIDITY IN THE SURFACE LAYER OF THE ATMOSPHERE
Afanas'ev A.L., Banakh V.A., Rostov A.P. **C2-16**

APPLICATION OF PARAMETRICAL STATISTICS FOR THE ANALYSIS OF FLUCTUATIONS OF AEROSOL SCATTERING COEFFICIENT IN THE SURFACE LAYER OF THE ATMOSPHERE
Razenkov I.A., Shefer N.A. **C2-17**

EFFICIENCY OF COHERENT RECEPTION WITH APERTURE ARRAY IN TURBULENT ATMOSPHERE
Banakh V.A., Werner X., Krivolutzkii N.P., Smalikho I.N. C2-18

ESTIMATE OF STATISTICAL CHARACTERISTICS OF "VOLNA-3" SODAR SIGNAL AMPLITUDES
Nevsorova I.V., Odintsov S.L. C2-19

THE "VOLNA-3" SODAR. CALIBRATION OF THE RECEIVING-TRANSMITTING PATH
Gladkikh V.A., Odintsov S.L. C2-20

ULTRASOUND ANEMOMETER-THERMOMETER "METEO-2"
Bogushevich A.Y., Gladkikh V.A. C2-21

MINISODAR FOR ATMOSPHERIC INVESTIGATION
Ivanov V.Yu., Krasnenko N.P., Stafeev P.G. C2-22

MEASUREMENT OF THE STRUCTURAL CHARACTERISTIC OF TEMPERATURE OF THE NEAR-GROUND LAYER OF THE ATMOSPHERE BY MEANS OF THE "VOLNA-3" SODAR
Gladkikh V.A., Nevsorova I.V., Odintsov S.L. C2-23

MICROWAVE REMOTE SENSING OF SOIL COVER
Mironov V.L., Komarov S.A., Kleshchenko V.N., Romanov A.N. C2-24

THE STUDY OF TEMPERATURE STRATIFICATION USING THE DATA OF RADIOMETRY, SOUND LOCATION AND RADIOSENSING
Lokoshchenko M.A., Kadygrov E.N., Viazankin A.S. C2-25

EXPERIMENTS WITH THE MOBILE SODAR SETUP
Lokoshchenko M.A. C2-26

Session: C3. Remote sensing studies of the Aerosol and Gas Composition of the Atmosphere and Optical Parameters of the Atmosphere and Ocean

Co-Chairs: Prof. A.P. Ivanov, Prof. G.G. Matvienko

INVITED SPEAKER: *Sunday, 16 July, 10:30. Main Hall*

10:30 LIDAR SYSTEM FOR ATMOSPHERIC POLLUTION MONITORING IN THE INDUSTRIAL CENTER
Ivanov A.P., Chaikovskii A.P., Khutko I.S., Osipenko F.P., Korol' M.M., Krachina I.V., Petukhov V.O., Churakov V.V., Rybal'chenko E.V., Slesar' A.S., Kopachevskii V.D., Kachinskii A.A., Bui A.A. C3-01

11:00 BREAK

ORAL REPORTS *Sunday, 16 July, 11:15–13:00. Main Hall*

11:15 STUDY OF CRYSTAL ORIENTATION IN CIRRUS CLOUDS BY LIDAR METHOD
Samokhvalov I.V., Kaul B.V., Romashov D.N., Stykon A.P., Bryukhanova V.V., Batrakov G.Yu. C3-02

11:30 LIDAR SIGNAL STRUCTURE FROM REMOTE AEROSOL FORMATION CONSIDERING DOUBLE SCATTERING
Bryukhanova V.V., Samokhvalov I.V. C3-03

11:45 LIGHT BACKSCATTERING BY HEXAGONAL ICE CRYSTALS
Borovoi A.G., Naatz E.I., Oppel U.G. C3-04

12:00 ALTITUDE PROFILES OF CLOUDY AND AEROSOL CHARACTERISTICS IN THE TROPOSPHERE ACCORDING TO SATELLITE LIDAR MEASUREMENTS
Avdyushin S.I., Smerkalov V.A., Tulinov G.F., Tulinov S.G., Ushakova L.K., Melnikov V.E., Laletina E.A. C3-05

12:15 STUDYING MICROSTRUCTURE OF THE STRATOSPHERIC AEROSOL BY LASER SOUNDING DATA
Chaikovskii A.P., Ivanov I.S., Osipenko F.P., Shcherbakov V.N., Pukhal'skii S. , Sobolevskii P. C3-06

12:30 STUDY OF AEROSOL AND WIND FIELDS IN ATMOSPHERIC BOUNDARY LAYER OVER BAIKAL LAKE BY REMOTE METHODS
Ershov A.D., Balin Yu.S., Belan B.D., Ivlev G.A. C3-07

12:45 VERTICAL PROFILES OF AEROSOL SCATTERING IN UPPER ATMOSPHERE ACCORDING TO ULTRAVIOLET OBSERVATIONS FROM SPACE WITH INSTRUMENTAL SPATIAL AVERAGING TAKEN INTO ACCOUNT
Myasnikov V.M., Cheremisin A.A., Granitzkii L.V., Vetchinkin N.V. C3-08

13:00 LUNCH

INVITED SPEAKER: *Sunday, 16 July, 14:15. Main Hall*

14:15 AEROSOL CHARACTERIZATION WITH ADVANCED AEROSOL LIDAR FOR CLIMATE STUDIES
Althausen D., Mueller D., Wagner F., Franke K., Wandinger U., Ansmann A. C3-09

ORAL REPORTS *Sunday, 16 July, 14:45–16:15. Main Hall*

14:45 ULTRAVIOLET OBSERVATIONS FROM SPACE INTO A TRACE EFFECT OF SPACE SHUTTLE LAUNCHES ON AEROSOL AND OZONE OF THE EARTH'S UPPER ATMOSPHERE
Cheremisin A.A., Granitzkii L.V., Myasnikov V.M., Vetchinkin N.V. C3-10

15:00 SPECIFIC FEATURES OF VERTICAL DISTRIBUTION OF STRATOSPHERIC OZONE OVER TOMSK ACCORDING TO DATA OF MULTIYEAR LIDAR OBSERVATIONS
Marichev V.N., Zuev V.V., Khryapov P.A. C3-11

15:15 OPTIMIZATION OF LIDAR MEASUREMENTS IN UV SPECTRAL RANGE AND CALCULATION OF GAS CONCENTRATION VERTICAL PROFILE
Shcherbakov V.N., Ivanov A.P., Bril A.I., Kabashnikov V.P., Popov V.M., Chaikovskii A.P. C3-12

15:30 ANALYTICAL MODEL OF SPECTROSCOPIC CW-WM-LD-DR-LADAR
Agishev R.R., Sagdiev R.K. C3-13

15:45 ESTIMATE OF RANGING LIMIT FOR DA LIDAR BASED ON CO_2 LASERS
Sherstov I.V., Ivashchenko M.V. C3-14

16:00 LIDAR DETERMINATION OF POWER RELATIONSHIP BETWEEN ATMOSPHERIC BACKSCATTERING AND EXTINCTION
Yegorov A.D., Shchukin G.G. C3-15

POSTER REPORTS *Monday, 17 July, 16:45–19:00.*

ARCTIC HAZE, CLOUD EMISSIVITY, AND CLIMATE WARMING
Radke L.F., Ogren J., Stone R.S., Andrews E.A., Dutton E.G. C3-16

LIDAR MEASUREMENTS OF THE VOLUMETRIC BACKSCATTERING COEFFICIENT OVER NORTH TIEN-SHAN
Tashenov B.T., Filippov V.A., Lyadzhin V.A., Filippov R.V. C3-17

THE MASS SPECTROMETRY OF VAPORISATION BY THE LASER RADIATION OF THE AEROSOL PARTICLES (ANALYSIS OF ARTEFACTS)
Belov N.N., Belova N.G. C3-18

REMOTE ACTIVE SOUNDING OF THE DROPLET SIZES BY SENSING OF THE THIRD HARMONIC GENERATION INSIDE THE PARTICLES FOR FEMTOSECOND LIDAR RADIATION
Belov N.N., Belova N.G. C3-19

CONTRIBUTION OF URBAN AEROSOL TO ERROR OF DETERMINING ATMOSPHERIC GAS CONCENTRATION BY DIFFERENTIAL ABSORPTION METHOD
Barun V.V. C3-54

MUELLER MATRIX OF HEXAGONAL ICE CRYSTALS
Borovoi A.G., Naatz E.I., Sazanovich V.M., Grishin I.A., Oppel U.G. C3-55

DATABANK FOR INTERPRETING RESULTS OF POLARIZATION SENSING OF ICE-CRYSTAL CLOUDS
Romashov D.N., Kaul B.V., Samokhvalov I.V. C3-56

MODEL CALCULATIONS OF SPECTRA OF THE BRIGHTNESS COEFFICIENTS FOR THE INTERPRETATION OF SPECTROMETRIC DATA ON A FRESH WATER QUALITY
Sukhorukov B.L., Garbuzov G.P., Akavets A.A. C3-57

Session: C4. Airborne lidars

Chair.: Prof. G.G. Matvienko

ORAL REPORTS *Sunday, 16 July, 16:30–17:30. Main Hall*

16:30 TRENDS IN THE DEVELOPMENT OF AIRBORNE LIDARS
Matvienko G.G., Shamanaev V.S. C4-01

16:45 INVESTIGATIONS OF OPTICAL CHARACTERISTICS IN THE AIRCRAFT TRACES
Lukin V.P., Emaleev O.N., Petrov A.I. C4-02

17:00 PROPAGATION OF PARTLY COHERENT LASER RADIATION ON THE LONG ATMOSPHERIC PATHS UNDER THE CONDITIONS OF THERMAL NONLINEARITY
Zemlyanov A.A., Kolosov V.V. C4-03

17:15 MONITORING OF ENVIRONMENTAL POLLUTION BY UNBURNED ROCKET PROPELLANTS
Sherstov I.V., Ivashchenko M.V. C4-04

POSTER REPORTS *Monday, 17 July, 16:45–19:00*

TROPOPAUSE TURBULENCE MEASUREMENTS
Otten L.J., Jones A., Black D., Lane J., Roggemann M., Hugo R. C4-05

ADAPTIVE PUMP OSCILLATOR FOR A PORTABLE CO_2 TRANSMITTER OF LIDAR SYSTEMS
Danilaev M.P., Pol'skii Yu.E. C4-06

AIRCRAFT LIDAR FOR RESEARCH OF AEROSOL DISTRIBUTION IN ATMOSPHERIC BOUNDARY LAYER
Shishkov P.O. C4-07

CAPABILITIES OF AIRBORNE VIEW-ANGLE SCANNING LIDAR
Beresnev A.V., Abramochkin A.I., Tikhomirov A.A. C4-08

PECULIARITIES OF LASER RANGING OF THE EARTH SURFACE FROM ONBOARD OF A SPACECRAFT
Tikhomirov A.A. C4-09

ANALYSIS OF POLARIZATION CHARACTERISTICS OF DIFFERENT SCANNERS FOR AIRBORNE LIDARS
Beresnev A.V., Tikhomirov A.A. C4-10

PULSED DOPPLER LIDAR MEASUREMENT OF THE WIND USING THE AUTOCORRELATION FUNCTION METHOD
Shelekhov A.P. C4-11

USINGE OF THE DF LASER IN BOARD - BASED LIDAR FOR DETECTION OF AEROSOL AND GAS LEAKAGES
Matvienko G.G., Ptashnik I.V., Romanovskii O.A., Kharchenko O.V., Shamanaev V.S. **C4-12**

MODELLING CRITERIA SELECTION DURING ELABORATION OF LIDAR COMPLEX GAS DISCHARGE LASERS PUMPING SYSTEMS
Aibatov L.R. **C4-13**

Session: D1. Optical and Microphysical Properties of Atmospheric Aerosols

Co-Chairs: Prof. Yu.A. Pkhalagov, Prof. L.S. Ivlev

INVITED SPEAKER *Wednesday, 19 July, 9:00. Main Hall*

9:00 THE INFLUENCE OF ENTERING SUBSTANCE ON THE OPTICAL PROPERTIES OF HIGHER ATMOSPHERE
Ivlev L.S., Kondrat'ev K.Ya., Khvorostovskii S.N. **D1-01**

DEVELOPMENT OF CRYSTAL FORMATIONS IN THE UPPER TROPOSPHERE ASSOCIATED WITH THE SOLAR PROTON BURSTS
Ivlev L.S., Pudovkin M.I., Khvorostovskii S.N. **D1-02**

ORAL REPORTS *Wednesday, 19 July,9:00–11:45. Main Hall*

9:30 VARIATION OF SUSPENDED PARTICULATE CONCENTRATION IN THE MOUNTAINOUS COASTAL CITY
Choi H. **D1-03**

9:45 PECULIARITIES OF TEMPORAL BEHAVIOR OF THE FINE AEROSOL AND SOOT CONTENTS IN THE NEAR-GROUND AIR LAYER
Kozlov V.S., Panchenko M.V., Yausheva E.P. **D1-04**

10:00 RESALTS OF STUDY THE SUBMICRON AEROSOL ABSORPTION OF IR RADIATION
Uzhegov V.N., Pkhalagov Yu.A. **D1-05**

10:15 SPECTRAL LIDAR INTEGRATING NEPHELOMETER FOR ATMOSPHERIC IN SITU INVESTIGATIONS OF THE SCATTERING COEFFICIENT
Razenkov I.A., Cha H.K., Rostov A.P., Kim D.H. **D1-06**

10:30 TRANSFORMATION OF AEROSOL DISPERSED COMPOSITION FROM BACKGROUND TO THE CONVENTIONAL STATE BASED ON THE MEASUREMENTS OF AEROSOL OPTICAL THICKNESS (AOT). 1. COARSE FRACTION. 2. SECONDARY AEROSOL
Rakhimov R.F., Makienko E.V., Sakerin S.M. **D1-07, D1-08**

10:45 THE DETERMINATION OF ATMOSPHERIC GASES AND AEROSOL PARAMETERS BASED ON AIRBORNE MEASUREMENTS OF SPECTRAL FLUXES
Vasilyev A.V., Ivlev L.S. **D1-09**

11:00 BREAK

11:15 ESTIMATION OF EXTINCTION, SCATTERING AND ABSORPTION CROSS SECTIONS OF ISOTROPIC POLYDISPERSIONS OF SPHERICAL PARTICLES
Abdulkin V.V., Paramonov L.E. **D1-10**

11:30 SOLUTION OF THE INVERSE LIGHT-SCATTERING PROBLEM FOR SUSPENSION OF BIOLOGICAL PARTICLES ON THE BASE OF THE SCANNING FLOW CITOMETRY
Shepelevich N.V., Prostakova I.V., Lopatin V.N. **D1-11**

POSTER REPORTS *Tuesday, 18 July, 16:30–19:00*

ANNUAL BEHAVIOR OF AEROSOL CONDENSATION ACTIVITY IN THE NEAR-GROUND LAYER OF THE ATMOSPHERE
Terpugova S.A., Panchenko M.V., Yausheva E.P. **D1-12**

EXTENSION OF MEASUREMENT PARAMETERS OF PHOTOELECTRIC COUNTERS IN COLOR BANDS
Pol'skii Yu.E., Dautov O.Sh., Ivanova P.Yu. **D1-13**

LIGHT SCATTERING INTO SOLID ANGLES. APPLICATION TO PHOTOMETERS WITH VARIED GEOMETRY OF INCIDENT LIGHT
Chukanova E.V. **D1-14**

NUCLEATION RATE IN VAPOR-GAS MIXTURE WITH VAPOR SOURCE AT BOUNDARY ON EXAMPLE OF STATIC DIFFUSION CHAMBER
Anisimov M.P., Shandakov S.D., Pinaev V.A., Belyshev A.V., Shandakova G.V. **D1-15**

COMPLEX LABORATORY STUDIES OF THE MARINE AEROSOLS
Gubareva T.V., Korobetzkii I.A., Shudrikov E.S. **D1-16**

ABOUT BIMODAL AEROSOL SIZE DISTRIBUTION
Anisimova L.M., Pinaev V.A. **D1-17**

THERMOMICROSTRUCTURAL ANALYSIS OF THE SUBMICRON AEROSOL
Kopeykin V.M. **D1-18**

ON THE EFFECT OF OPTICAL CHARACTERISTICS OF THE ATMOSPHERE ON THE DEPENDENCE OF THE CLOUDLESS HORIZON BRIGHTNESS ON THE AZIMUTH
Zhuravleva T.B., Sakerin S.M. **D1-19**

LONG-TERM OBSERVATIONS OF THE ATMOSPHERIC AEROSOL CHEMICAL COMPOSITION AT THE SOUTH OF WEST SIBERIA IN SECOND HALF OF 90th
Simonenkov D.V., Rasskazchikova T.M., Belan B.D., Tolmachev G.N., Loguntzev A.E. **D1-20**

SPECTRAL MODIFICATION BEER'S LAW AND RELATION FROM HUMIDITY ATTENUATION COEFFICIENT IN THE ATMOSPHERIC SEABOARD HAZE
Vulfson A.N. **D1-21**

ON THE ESTIMATE OF SINGLE SCATTERING ALBEDO OF FINE AEROSOL FROM THE DATA ON THE SCATTERING COEFFICIENT AND SOOT CONCENTRATION
Kozlov V.S., Panchenko M.V. **D1-22**

THE STUDY OF THE REDUNDANT ABSORPTION OF VISIBLE RADIATION IN LABORATORY CONDITIONS
Shchelkanov N.N. **D1-23**

ON THE SPECTRAL DEPENDENCE OF THE REDUNDANT ABSORPTION OF OPTICAL RADIATION IN THE WAVELENGTH RANGE 0.4–12 μm
Shchelkanov N.N., Pkhalagov Yu.A. **D1-24**

THEORETICAL INVESTIGATION OF SPEQULAR REFLECTION FROM ORIENTED PLATES AS APPLIED TO BISTATICAL SENSING
Shefer O.V. **D1-25**

STATISTICAL COMPARISON OF EXPERIMENTAL DATA AND MODEL ESTIMATES OF THE AEROSOL EXTINCTION
Rakhimov R.F., Uzhegov V.N. **D1-26**

VARIATIONS OF MICROPHYSICAL PARAMETERS OF ATMOSPHERIC AEROSOL ON SPECTROPOLARIMETRICAL INVESTIGATIONS
Isakov A.A. **D1-27**

SIMULATION OF INTERACTION OF GASES WITH WATER DROPLET SURFACE.
I.E.Cherlina **D1-28**

Session: D2. Transport and Transformation of Atmospheric Aerosol and Gaseous Components

Chair: Prof. B.D. Belan

ORAL REPORTS *Tuesday, 18 July, 9:00–10:30. Small Hall*

9:00 SIMULATION OF GLOBAL METHANE CYCLE
Krupchatnikov V.N., Krylova A.I. **D2-01**

9:15 GEOINFORMATION ANALYSIS OF ATMOSPHERE POLLUTION IMPACT ON LANDSCAPE OF SIBERIAN OILPRODUCTION TERRITORIES
Tokareva O.S., Polishchuk Yu.M. **D2-02**

9:30 STUDY OF ANTARCTIC OZONE HOLE USING TOMS/EP SATELLITE DATA
Kashkin V.B., Sakash I.Yu., Novik V.M., Romas'ko V.Yu. **D2-03**

9:45 ANALYSIS OF THE AEROSOL CONCENTRATION FLUCTUATIONS
Gorchakov G.I., Shukurov K.A. **D2-04**

10:00 THE ROLE OF MICROPHYSICAL AND DYNAMICAL PARAMETERS IN THE ATMOSPHERE REGULATING PROCESSES
Vasiliev S.L., Ivlev L.S. **D2-05**

10:15 ABOUT EXTENSION OF OPPORTUNITIES OF THE MARCHUK METHOD THE DECISIONS OF "INVERSE" TASKS OF ATMOSPHERIC IMPURITY DISPERSION
Desyatkov B.M., Borodulin A.I., Sarmanaev S.R., Kotlyarova S.S. **D2-06**

POSTER REPORTS *Tuesday, 18 July, 16:30–19:00*

NUMERICAL SIMULATION OF AIR POLLUTION ABOVE SOUTH BAIKAL AREA AT LOCAL WINDS
Makukhin V.L., Potemkin V.L. **D2-07**

OBSERVATIONS OF ECOLOGICAL STATE OF EARTH'S SURFACE AND NEAR-EARTH ATMOSPHERIC LAYER ALONG DIRECTION SOSNOVY BOR – NORTH-EAST OF ST.PETERSBURG
Ivlev L.S., Vlasenko S.S., Zhukov V.M., Kudryashov V.I., Salin V.I. , Terekhin N.Y. **D2-08**

WAVELET ANALYSIS OF QUASIPERIODICAL STRUCTURES IN ATMOSPHERIC BOUNDARY LAYER
Shishkov P.O. **D2-09**

SURFACE OZONE VARIABILITY IN EUROPEAN CENTRAL RUSSIA
Zvyagintzev A.M., Kuznetsova I.N. **D2-10**

SPECTRAL METHODS OF THE ANALYSIS OF THE STRUCTURE OF THE AEROSOL CONVECTIVE BOUNDARY LAYER
Zakharova P.V. **D2-11**

INTERPOLATION OF MESOSCALE GEOPOTENTIAL FIELD INTO ATMOSPHERIC BOUNDARY LAYER APPLIED TO THE PROBLEM OF NUMERICAL FORECASTING OF AIR POLLUTION
Komarov V.C., Kreminckii A.V., Lomakina N.Y., Popov Y.B., Sinyova K.Y. **D2-12**

THE CHANGE OF THE COMPOSITION OF AIR WHEN ATMOSPHERIC FRONTS PASS
Arshinova V.G., Belan B.D., Rasskazchikova T.M. **D2-13**

SIMULATION OF SPREADING AND TRANSFORMATION OF SULPHUR AND NITROGEN COMBINATIONS IN THE ATMOSPHERE OF SOUTHERN REGION A ROUND LAKE BAIKAL
Arguchentzev V.K., Makukhin V.L. **D2-14**

ON THE QUESTION OF ANTHROPOGENIC EFFECT ON CONCENTRATION OF OZONE AND AEROSOL IN THE NEAR-GROUND LAYER OF THE ATMOSPHERE
Arshinova V.G., Belan B.D., Rasskazchikova T.M. **D2-15**

AEROSOL AND RADON STREAMS VARIABILITY IN A TECTONIC FAULT ZONE
Grishin A.I., Alekseev V.A., Alekseeva M.O., Matvienko G.G., Nevinskii I.O., Reshetkin A.Y., Smirnov V.S., Tsvetkova T.I. **D2-16**

ELEMENTAL COMPOSITION OF AEROSOLS OVER THE FORMER USSR
Tolmachev G.N. **D2-17**

MEASUREMENTS OF METHANE BACKGROUND CONCENTRATION IN WINTER PERIOD, 2000, IN TOMSK
Safonov V.S., Kapitanov V.A., Ponomarev Y.N. **D2-18**

PECULIARITIES OF THE SEASONAL VARIABILITY OF THE NEAR-GROUND OZONE CONCENTRATION IN THE ATMOSPHERE OF BAIKAL REGION
Butukhanov V.P., Zhamsueva G.S., Zayakhanov A.S., Lomukhin Yu.L. **D2-19**

ISOLATION OF THE LOCAL ANTHROPOGENIC COMPONENT OF ATMOSPHERIC AEROSOL BY SYNCHRONOUS SAMPLING OF THE NEAR-GROUND AEROSOL
Simonenkov D.V., Belan B.D., Loguntzev A.E., Rasskazchikova T.M., Tolmachev G.N. **D2-20**

SPATIAL DISTRIBUTION OF CHEMICAL COMPOSITION OF ATMOSPHERIC AEROSOL OVER RUSSIA
Loguntzev A.E., Belan B.D., Simonenkov D.V. **D2-21**

DYNAMICS OF THE VERTICAL DISTRIBUTION OF AEROSOL OVER WEST SIBERIA (1997–1999)
Belan B.D., Panchenko M.V., Inoue G. , Machida T. , Arshinov M.Yu., Plotnikov A.P. **D2-22**

ASSESSMENT OF A CONTRIBUTION OF NO_2 TO THE AEROSOL FORMING PROCESSES
Arshinov M.Yu., Simonenkov D.V. **D2-23**

DIURNAL BEHAVIOR OF THE CONCENTRATION OF ULTRAFINE AND FINE PARTICLES
Arshinov M.Yu. **D2-24**

Session: D3. Models, Databases, and Software for Solving Atmospheric Optics Problems

Co-Chairs: Prof. E.P.Gordov, Prof. V.V.Penenko

INVITED SPEAKERS *Wednesday, 19 July, 11:45–12:45. Main Hall*

11:45 INVERSE PROBLEMS AND ATMOSPHERIC MONITORING INFORMATIVE QUALITY
Penenko V.V. **D3-01**

12:15 ON LOW-DIMENSIONAL CLIMATE MODELS
Rodimova O.B. **D3-02**

ORAL REPORTS *Wednesday, 19 July,12:45–15:45. Main Hall*

12:45 INTEGRATED WEB INFORMATIOM-COMPUTATIONAL SYSTEM "ATMOSPHERIC OPTICS"
Gordov E.P., Babikov Yu.L., Belan B.D., Golovko V.F., Panchenko M.V., Rodimova O.B., Fazliev A.Z. **D3-03**

13:00 LUNCH

14:15 WEB ICS "ATMOSPHERIC CHEMISTRY". FIRST RESULTS
Fazliev A.Z., Gordov E.P., Adamov D.P., Karyakin A.S., Mikhailov S.A., Rodimova O.B., Akhlyostin A.Yu. **D3-04**

14:30 WEB INFORMATION SYSTEM: ATMOSPHERIC SPECTROSCOPY
Babikov Yu.L., Golovko V.F., Rodimova O.B., Fazliev A.Z. **D3-05**

14:45 USE OF THE DATA OF METEOROLOGICAL OBSERVATION AND LIDAR SOUNDING FOR NUMERICAL SIMULATION OF AEROTHERMOCHEMICAL PROCESSES IN THE ATMOSPHERE
Starchenko A.V., Balin Yu.S., Bogushevich A.Y., Gordov E.P. **D3-06**

15:00 ABSORPTION KOEFFICIENTS DATA BASE. CONCEPTION
Mitsel A.A., Okladnikov I.G., Milyakov A.V., Tashkun S.A., Kataev M.Y. **D3-07**

15:15 EFFECTIVE CLOUD FRACTION IN VISIBLE WAVELENGTH RANGE: A NUMERICAL MODEL
Zhuravleva T.B., Shohor L.N. **D3-08**

15:30 TO THE QUESTION ABOUT IMPROVING PROGRAMME AND ALGHORITHMICAL MAINTENANCE OF THE TASKS OF RESTORING VERTICAL PROFILES OF METEOROLOGICAL VALUES
Filimonov R.I., Akselevich V.I. **D3-09**

POSTER REPORTS *Tuesday, 18 July, 16:30–19:00*

DEVELOPMENT OF LINE-BY-LINE METHOD
Milyakov A.V., Mitsel A.A., Ptashnik I.V. **D3-10**

MATHEMATICAL METHODS OF DATA COMPRESSION
Okladnikov I.G., Mitsel A.A. **D3-11**

NONHYDROSTATIC MODEL OF THE STRATIFIED RESERVOIRS
Arguchentzev V.K., Arguchentzeva A.V. **D3-12**

THE MODELING OF FLIGHT VEHICLE EMISSION SPECTRA AND THEIR TRANSFER IN REAL ATMOSPHERE
Antipin M.E., Voitzekhovskaya O.K., Sheludyakov T.Yu. **D3-13**

APPLICATION OF ODRIS SYSTEM TO REVEAL TEMPORAL AND SPATIAL REGULARITIES IN OZONE AND OTHER ATMOSPHERIC PARAMETERS CHANGES
Boichenko I.V., Marichev V.N. , Kataev M.Y. **D3-14**

ICS "ATMOSPHERIC OPTICS". DATABASES
Karyakin A.S., Adamov D.P. , Gordov E.P. , Mikhailov S.A. , Morozov D.N., Fazliev A.Z. **D3-15**

APPLICATION OF OBJECT-ORIENTED APPROACH FOR REALIZATION OF ALGORITHMS REPRESENTED AS ORIENTED GRAPH IN A SOFTWARE SYSTEM ODRIS
Boichenko I.V. **D3-16**

A SIMULATION OF THE TURBULENT EXCHANGE IN NEAR SURFACE LAYER OF THE ATMOSPHERE AND WATER BODIES
Shlychkov V.A. **D3-17**

NUMERICAL SIMULATION OF CONVECTIVE MIXION OF THE UPPER LAYER OF WATER RESERVOIR IN AUTUMN AND WINTER
Shlychkov V.A., Pushistov P.Yu. **D3-18**

AUTOMATION OF PROGRAMMING LARGE-VOLUME LIDAR-DATA PROCESSING
Bazhenov O.E., Bondarenko S.L., El'nikov A.V. **D3-19**

SIMULATION OF THE TURBULENT TRANSFER AT THE DIURNAL EVOLUTION OF THE HOMOGENEOUS ATMOSPHERIC BOUNDARY LAYER.
Starchenko A.V., Karyakin A.S. **D3-20**

APPLICATION OF COMPUTER CLUSTER FOR THE CALCULATIONS IN ICS "ATMOSPHERIC CHEMISTRY"
Adamov D.P., Mikhailov S.A., Fazliev A.Z. **D3-21**

THE MATHEMATICAL MODEL OF THE ELECTRICAL AND METEOROLOGICAL CHARACTERISTICS RELATIONSHIP
Ovcharenko E.V., Donchenko V.A., Kalayda V.T. **D3-22**

THE REGULARIZING PROPERTIES OF MEASURING THE STATE VARIABLES' DERIVATIVES IN THE PROBLEM OF ESTIMATION OF DYNAMICAL PROCESSES
Trofimenko V.N., Trofimenko K.V. **D3-23**

GEOSIMULATION AND ASSESSMENT OF ATMOSPHERE CHEMICAL POLLUTION IMPACT
Rukhko V.V., Polishchuk Yu.M. **D3-24**

Session: D4. Optical Diagnostics of the State and Evolution of Vegetative Biosystems

Chair: Prof. Yu.N. Ponomarev

ORAL REPORTS *Tuesday, 18 July, 11:15–12:12. Small Hall*

11:15 THE METHOD OF LASER–INDUCED FLUORESCENCE IN THE PROBLEMS OF INVESTIGATION OF THE PHOTOSYNTHESIS SYSTEM OF TREES
Vorob'eva N.A., Grishin A.I., Zotikova A.P., Matvienko G.G., Romanovskii O.A., Kharchenko O.V. **D4-01**

11:30 MODERN DIRECTIONS OF APPLICATION OF THE CHLOROPHYLL FLUORESCENCE FOR THE STUDY OF NATURAL COMMUNITIES OF AQUATIC MICRO-PLANTS.
Gaevskii N.A., Gorbaneva T.B., Kolmakov V.I., Popelnizkii V.A., Gol'd V.M. **D4-02**

11:45 INTERCALIBRATION OF TWO METHODS OF QUANTITATIVE MEASUREMENTS OF CO_2 EMISSION FROM THE PEAT
Ageev B.G., Golovatskaya E.A., Dementyeva T.V., Inisheva L.I., Ponomarev Y.N., Sapozhnikova V.A. **D4-03**

12:00 CHLOROPHYLL FLUORESCENCE AS APPLIED TO BIOINDICATION OF THE ATMOSPHERIC POLLUTION
Grigoriev Y.S., Pakhar'kova N.V., Sobchak R.O., Kumandina M.N., Astafurova T.P., Sorokina G.A. **D4-04**

POSTER REPORTS *Tuesday, 18 July, 16:30–19:00*

THE CONTROL AND DIAGNOSTICS OF FOREST STATE BY THE INFRARED METHOD
Shishlov V.I. **D4-05**

UV CLIMATE IN THE CONDITIONS OF ANTHROPOGENIC ATMOSPHERIC CONTAMINATION
Usachev V.A., Yatsyk V.S. **D4-06**

MONITORING OF NATURAL UV RADIATION AND I-TS EFFECT ON THE ENVIRONMENT
Usachev V.A., Yatsyk V.S. **D4-07**

ON MATHEMATICAL SIMULATION OF PRODUCTIVITY OF FOREST PHYTOCENOSIS AND SOME ISSUES OF THEIR OPTICAL DIAGNOSTICS.
Grishin A.M. **D4-08**

THE ESTIMATING OF CONIFEROUS TREES STATE IN TOMSK WITH THE FLUORESCENCE METHODS
Khan L.V., Pakhar'kova N.V. , Grigoriev Y.S. , Astafurova T.P. **D4-09**

A1-01

STUDY OF THE H_2 EFFECTS ON O_3 CONCENTRATION IN BINARY $O_3 + H_2$ MIXTURE USING FTIR SPECTROMETRY TECHNIQUES

Barbe A., De Backer-Barilly M., Von Der Heyden P., Thomas X., Ponomarev Y.N.*, Zuev V.V.*

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The effect of molecular hydrogen, given out from the litosphere, on tropospheric and stratospheric ozone was discussed in Ref. 1, 2. The conclusions made by the authors of these works occured to be antripodal.

It was suggested in Ref. 1 that the molecular hydrogen may result in some decrease of ozone concentration due to the gas-phase reaction

$$H_2 + O_3 + M \rightarrow H_2O + O_2 + M.$$

In the process of which and excess concentration of water vapor appears at the heights of the ozone lager location. (In (1), M is the third molecule, N_2 for example). This water vapor causes a formation of clouds in the stratosphere, particularly, the polar stratrospheric clouds.

The model calculations from the Ref. 2 have shown that the emission of the H_2 into upper atmosphere results in its spontaneous combustion at the heights ~ 120 km with further burn out, almost total, at the heights of 165–200 km. In the process of the hydrogen burning out, the water vapor is formed, which drops down into ice pieces forming the silver clouds.

It is actual for both hypothesis is actual to study the efficiency and rate of simplest reaction $O_3 + H_2$ in gasphase under controlled pressure and temperature.

In this paper, we present the first results of the FTIR measurements of the O_3 and H_2 concentration variations in the cell filled previously by the binary mixtures of $^{18}O_3$ and H_2.

We are working with $^{18}O_3$ to select the spectra of formed $H_2{}^{18}O$ from the spectra of atmospheric $H_2{}^{16}O$ which is present in the air inside the FTIR set up.

The special absorption cell with a length of 31.2 cm was carefully pumped and after fulfilled by $^{18}O_3$ at partial pressure of 1 Torr and with high purity H_2 at partial pressure of 1 Torr also.

The spectra of $^{18}O_3$ and $H_2{}^{18}O$ are recorded simultaneously with the Fourier Transform Spectrometer of Reims, described elsewhere [3].

Together with the spectra of $H_2 + O_3$ mixture, we also have measured the spectra of $N_2 + {}^{18}O_3$ mixture to check the kinetics of O_3 concentration when H_2 is absent.

The special model experiment was made to determine the possibility to detect the appearance of $H_2{}^{18}O$ inside the FTIR absorption cell in comparison with the natural level of $H_2{}^{18}O$ in air inside the other volumes of FTIR. It was checked that we are sure in presence of $H_2{}^{18}O$ in absorption cell when its concentration is about 0.0005 torr.

Our experiments made at room temperature have clarified that we really check both results.

- $^{18}O_3$ decrease in $^{18}O_3 + H_2$ mixture is stronger (about 10%) that in $^{18}O_3 + N_2$ mixture.
- $H_2{}^{18}O$ really appears in the volume of the absorption cell fulfilled by $^{18}O_3 + H_2$ mixture, and its concentration is estimated to be equal to 0.001 torr after 3 hours from the prepared mixture.

The contribution of Ponomarev Yu.N. and Zuev V.V. is supported by RBRF (Grant No. 98–05–64267).

References

1. Syvorotkin B.Y., Privoda, N 9, 35–45 (1993) [in Russian].
2. Nikolaev Yu.A., Fomin G.F., Fizika Goren. i Vzryva, vol. 33, N 4, 3–13 (1997) [in Russian].
3. Plateaux J.J., Barbe A., Delahaigue A., Spectrochimica Acta, 51A, N 7, 1153–1169 (1995).

A1-02

ABSORPTION SPECTRUM OF HDO MOLECULE FROM IR TO VISIBLE SPECTRAL REGIONS

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Absorption spectra of the water vapour deuterated isotopic species HDO were investigated in the 13000–18350 cm^{-1} spectral region using a highsensitive intracavity laser absorption spectroscopy. Absorption lines of the eight vibrational bands were identified for the first time, while for the $4\nu_3$ and $5\nu_3$ bands the existing experimental information was significantly inlarged. The energy levels, rotational, centrifugal distortion and resonance constants as well as the effective transition moment prameters were derived in the frame of the effective Hamiltonian approach. These parameters allow to reproduce the HDO spectra close to experimental accuracy as well as to predict reasonably positions and intensities of weak HDO lines.

High-order unharmonic resonance interactions induced by the bending vibrations excitation were analyzed. Separate transitions involving rotational sublevels of the highly excited bending states as high as (0 12 0) were observed in the experimental spectrum borrowing their intensities from the resonance intensity redistribution. Resonace polyad structure in HDO is also discussed.

A1-03

ANOMALIES IN VIBRATIONAL SPECTRA OF INORGANIC HYDRIDES OF GROUP VA ELEMENTS IN THE CONDENSED PHASE

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Vibrational spectra of NH_3, PH_3, and AsH_3 in liquid phase (150–300 K) and solutions of liquified gases Ar (95 K), Kr (130 K), and Xe (180 K) for 5700-400 cm^{-1} region are investigated. The values of correlation time of angular moment for PH_3 and AsH_3 in liquid phase and in solution of liquid Ar are determined: $\tau_{rot} \cong 0.1$ps (liquid Ar, T = 95 K) and $\tau_{rot} \cong 0.2$ ps (liquid, T = 153 K).

The enthalpy of intermolecular interactions in liquid hydrides is estimated: $\Delta H_{298} = -1.7$ kkal·mol^{-1} (NH_3), $\Delta H_{298} = -0.1$ kkal·mol^{-1} (PH_3), $\Delta H_{298} \cong 0$ (AsH_3). The summarized band ν_1, ν_3 is shown to have the intensity $A = 119 \cdot 10^{-8}$ см^2·molec^{-1}·s^{-1} what is almost two times greater than the values of A for gas ($58 \cdot 10^{-8}$ см^2·molec^{-1}·s^{-1}), liquid ($72 \cdot 10^{-8}$ см^2·molec^{-1}·s^{-1}), and solutions of PH_3 in liquid Kr and Xe ($44 \cdot 10^{-8}$ and $49 \cdot 10^{-8}$ см^2·molec^{-1}·s^{-1}, respectively). At the same time, the magnitude of A for $2\nu_2$ PH_3 in liquid Ar is abnormally small comparative to $2\nu_4$, $\nu_2 + \nu_4$ and $3\nu_2$.

Using line shapes of $\nu_2(A_1)$ in PH_3 and AsH_3 Raman spectra, the correlation functions of vibrational ($G_V(t)$) and orientational ($G_R(t)$) relaxation are calculated. Analysis of time behavior of $G_V(t)$ and $G_R(t)$, as well as times of vibrational (τ_V) and rotational (τ_R) relaxation has shown the magnitude of τ_V to depend weakly on the temperature of liquid PH_3 and AsH_3 and to be in the limits of 1.2–1.5 ps. Unlike τ_V, the temperature decrease of liquid hydrides in the range of 298–181 K is accompanied by τ_R increase from 3.1 to 7.4 ps for PH_3 and from 0.4 to 4.8 ps for AsH_3.

It is shown that in polarization Raman spectra of liquid PH_3 and AsH_3 in $\nu_2(A_1)$ region, noncoincidence of line maxima is observed for isotropic and anisotropic Raman scattering ($\delta\nu = \nu_{aniso} - \nu_{iso}$). Decrease of hydrides temperature therewith from 295 K to 180 K is accompanied by $\delta\nu$ decrease from + 0.3 to + 1.8 cm^{-1} (PH_3) and from + 0.2 to – 4.7 cm^{-1} (AsH_3).

Based on the obtained data, we can make the following conclusions.

- among the hydrides which have been studied, NH_3 is mostly prone to self-association by the mechanism of H-bonds formation. In PH_3 the specific interactions accompanied by formation of self-associates with H-bond are essentially weaker than in NH_3. In liquid AsH_3 nonspecific interactions dominate as the temperature decreases.
- in solution of PH_3 in liquid Ar a formation of weakly-bound complex PH_3–Ar is possible. Abnormally small value of A for $2\nu_2$ band (PH_3) in liquid Ar is due to the fact that its intensity is defined only by the second derivative versus valence angles.
- in liquid hydrides, the association processes along with resonance exchange of vibrational energy may significantly contribute in noncoincidence of maxima of isotropic and anisotropic components of the Raman scattering.

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A1-04

COLLISIONAL INTERFERENCE OF VIBRONIC BANDS IN THE ARGON -BROADENED SPECTRUM OF OCS

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The possibility of collisional interference of vibronic bands in molecular spectra due to the isotropic part of the interaction potential was predicted in Ref. (1). The formulas for calculation the set of relaxation parameters and the absorption coefficient were also presented in this article. Here we give the results of calculations performed in accordance with the method developed in Ref. (1).

It was considered the interference of the following vibronic bands of OCS molecule in the argon atmosphere

$$\begin{cases} 10^01 \leftarrow 00^00, \ \nu_0 = 2918.4\,cm^{-1} \\ 14^00 \leftarrow 00^00 \ \nu_0 = 2935.7\,cm^{-1} \end{cases} \quad \text{and} \quad \begin{cases} 24^00 \leftarrow 00^00, \ \nu_0 = 3760.4\,cm^{-1} \\ 20^01 \leftarrow 00^00 \ \nu_0 = 3767.2\,cm^{-1} \end{cases}.$$

The calculations were performed at the temperature 296 °K for the argon pressure range $1 \le p \le 50$ atm. The interaction potential was taken from literature but its derivatives with respect to the normal coordinates were used as parameters.

It is shown that in both cases the interference leads to the bands intensities redistribution and appreciably distort the spectrum shape under high pressure.

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A1-05

AB INITIO DYNAMIC MODELS OF WEAKLY BONDED COMPLEXES IN ATMOSPHERE

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The appearance, stability, and optical activity of structurally nonrigid molecular complexes, incorporating chemically active and toxic molecules, which are able to cause additional radiation losses in the atmosphere of some industrial regions, is a topical problem of current atmospheric physics and chemistry. Solution of this problem requires, in particular, *ab inito* investigation of the structure and vibrational spectra of the complexes, which, contrary to the structurally nonrigid molecules, well-known in the literature,[1] are characterized by several types of movement of large amplitude (MLA).

This seriously hampers the detection and estimation of the complexes concentration in the atmosphere by means of the present-day techniques of remote sensing.[2] The presence of several types of MLA in weakly bonded complexes does not allow us to restrict ourselves to traditional concepts of molecular mechanics and geometry. Therefore, the definition of structure and description of vibrational spectra of such systems needs elaborating nontraditional theoretical approaches.

This work deals with constructing nonempirical dynamical models taking into account the specific peculiarities of the above systems. Low-frequency shift $\Delta\nu$ of vibrational band $\nu(HF)_{compl}$ relative to free molecule $\nu(HF)_{free}$ is studied with the complex $H_2O...HF$ as the example, using three model approaches

(1) one-dimensional model of independent harmonic oscillator HF ($\Delta\nu = 254$ см$^{-1}$);
(2) one-dimensional model of independent anharmonic oscillator HF ($\Delta\nu = 305$ см$^{-1}$);
(3) two-dimensional model of anharmonic oscillator HF interacting with valence intermolecular mode $H_2O...HF$ ($\Delta\nu = 306$ см$^{-1}$).

Comparison with experimental value $\Delta\nu = 354$ см$^{-1}$ points to significant contribution of anharmonic corrections into the magnitude of low-frequency shift $\Delta\nu$. The conducted analysis allows us to recommend the approaches (2) and (3) for investigation of wide range of spectroscopic molecular complexes of donor-acceptor type under conditions of real atmosphere.

This work is supported by the Russian Foundation for Basic Research (grant No. 05–64919).

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A1-06

THE SOLAR RADIATION ATTENUATION BY WEAK WATER VAPOR ABSORPTION LINES IN THE NEAR INFRARED AND VISIBLE REGION

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The essential difference between calculated and measured radiation balance in Earth atmosphere has been already noted by many authors. The difference is large for cloud atmosphere and diffuse radiation stream in the visible and near infrared spectral region, and it is strongly correlated with water amount in atmosphere. We suggest that this difference can be explained by contribution of the weak water vapor absorption lines, which can be seen at the long atmospheric paths. This assumption is in accord with resent spectral measurements of direct solar radiation stream, passed through atmosphere, where any extra absorption was not found, because the path was relatively short.

In the present report, the calculations of radiation attenuation by weak water vapor lines at the inclined atmospheric paths will be presented. The analysis of the wave length dependence of the weak line absorption as well as continuum absorption will be performed, the path length dependencies will be also analyzed.

The results of ab initio calculation of the H_2O line positions and strengths reported by Partridge and Schwenke are used. The total number of water vapor absorption lines involved in the present calculations exceed by the 1000 times those contained in the HITRAN-96 data bank.

A1-07

PROBABILITY OF SIMULTANEOUS TRANSITIONS IN CO_2 WITH HF AND HCL MIXTURES

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Integral intensities of bands of simultaneous vibrational transitions in absorption spectra of gaseous and liqvid mixtures of CO2 with HF and HCl were measured and calculated in approximation of electrostatic induction. Non-empirical quantum-mechanical calculations of probabilities of simultaneous transitions for presented systems were also carried out. It was shown, that

it is necessary to take into account an additional absorption due to heterocomplexes connected by H-bonds for intensity of IR absorption spectra over the region of the observed simultaneous transitions. Width, bandshapes and absolute intensity values of fundamental and overtone bands in IR absorption spectra of HCl dissolved in liquid carbon dioxide were investigated. Multiple increase in integral intensity of the fundamental band and some its decrese in a range of the first overtone of HCl vibration were revealed. The mechanisms of the formation of intensities for studied spectra are discussed.

A1-08

ON A DOUBLET STRUCTURE OF THE LOW-FREQUENCY IR ABSOPTION SPECTRA OF SOME AROMATIC COMPOUNDS

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Data on vibrational spectra of polycyclic aromatic hydrocarbons (PAHs) are of interest for astrophysical problems of identification of the diffusion bands entering the IR-spectra of interstellar medium.[1] High density of the PAH vibration states and closeness of frequencies of the vibrations, active in IR spectral range, hinder the reliable identification of these compounds by fundamental absorption bands. In this connection, such additional characteristic of IR spectra of the PAH as doublet structure of some bands, first reported in [2], becomes of prime importance.

To continue our works [2–4] performed earlier in order to increase the efficiency in identification of composite organic compounds, in this report we present the results of experimental and theoretical investigations of IR absorption spectra doublet structure for anthracene ($C_{14}H_{10}$) and naphthalene ($C_{10}H_8$) as typical representatives of PAHs in the region of fundamental vibrational bands of anthracene (469 $см^{-1}$, B_{3u}) and naphthalene (475 $см^{-1}$, B_{1u}).

The experiments were conducted using the IR Fourier- spectrometers (Bruker IFS–113v and Vector–22). Shifts of the line centers forming the doublet structure as well as redistribution of intensity between components were recorded within the temperature interval 293–450 K. The rates of the absorption line centers shifts for the doublet components were determined as well as relation between their intensities at temperature variation. A diversity of energetic levels, occasionally situated closely, have been studied for the case when the conditions necessary for interaction of corresponding energetic states result in the Fermi resonance. From comparison of calculation results for intensity in the doublet components of the Fermi resonance with the experimental ones, we have found the energy of interaction of resonant levels.

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A1-09

GENERAL PROPERTIES OF SHORT PULSES PROPAGATION IN RELAXATION RESONANCE MEDIUM

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Studying the dynamics of shape variation of short pulses propagating through a medium is a promising method to attack the problem of determining the dispersion-dissipation properties of media. Note, that as distinguished from the traditional methods, which use quasimonochromatic electromagnetic pulses of some carrier frequency's envelope, it becomes possible now to generate supershort light pulses in femtosecond range of only several wavelengths length and, consequently, of wide spectrum. As a consequence, their transformation carries much richer information on high-rate transient processes in a medium.

The previous investigations of the authors have shown that the efficiency of a medium properties diagnosis with short pulses of small amplitude can in some cases exceed the spectroscopic methods used traditionally. Thus, in particular, for Debue function of response of a medium we have worked out the technique for determination of parameters of relaxation times spectrum based on regularities of acoustic pulses propagation. The efficiency of this technique was experimentally proved.

New concepts of short pulses propagation through the homogeneous medium with resonance relaxation are reported. On this base, general regularities of the short pulses propagation in relaxation resonance media have been studied.

In particular, various types of pulse shape dynamics are analyzed from the standpoint of their use in diagnosis depending on relation of the medium relaxation and resonance properties.

A1-10

ENERGY SHIFT IN ATOMIC AND MOLECULAR SPECTRA INDUCED BY THE BLACKBODY RADIATION FIELD

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The paper deals with atoms/molecules coupled to an equilibrium photon thermostat. The coupling results in population redistribution (the line width) and the shift of quantum energy levels. An analytical expression for the energy shift versus the thermostat temperature has been obtained within the density matrix formalism. At low temperatures the shift is proportional to the squared temperature and leads to observable effects on the rotational states of molecules and high-exited atomic states. The shift 's magnitude at room temperature (300K) is of the order of 1kHz.

A1-11

SOFTWARE PACKAGES FOR A COMPARATIVE ANALYSIS OF SPECTROSCOPIC DATABASES

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Software packages designed for a comparative analysis of molecular spectroscopic parameters archived in different databases have been developed. Various versions of software output the following information:

- Stick spectra for each database
- Histograms of the spectral lines intensity distribution
- Graphical representation of differences in positions, halfwidths, intensities and temperature coefficients of spectral lines from two different databases.

The software can be run on computers with UNIX operation system. An internet-accessible version with user-friendly interface has been developed.

These programs have been applied to an analysis of GEISA-92, GEISA-97 [1], and HITRAN-96 [2] spectroscopic databases.

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A1-12

THEORETICAL STUDY OF H-BOND COMPLEXES ELECTRONIC SPECTRA

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Ab initio study of $(H_2O)_n (HCl)_m$, n, m ≤ 2, low electronic states has been done. The split-valence type of basis set was used. The full electronic energies were calculated at SCF (self-consistent-field) and CI (configuration interaction) level of theory. Excitation energies of $S_0 > S_1$ and $S_0 > T_1$ were determinated. The electronic redistribution under these transitions was calculated and analysis of electronic transition nature has been done. Rydberg character for these complexes has place like as water monomer. The maximum band has short wave shift that fact show on weakening of hydrogen bonding under electronic excitation.

The energy of a state, $^{2s+1}\Gamma$, arising from the molecular open-shell electronic configuration r^N, was described in the restricted open-shell Hartree – Fock (ROHF) method. It was shown that adiabatic approximation is kept even with greater accuracy for complexes under comparison with molecules[1]. But for study of electronic excited states it is necessary to use a new level of theory. The electron correlation was included via CI level of theory.

The influence of hydrogen bond formation on the shift in the maximum of first absorption band of these complexes was examined. The investigations of electronic excited states of molecules allow solving some analytical problems. One of them it is a problem about identification of substances. In virtue of data about electronic excited states it is possible to carry out a study of photophysical and photochemical processes what take place after photon absorption. From an analysis of experimental data follow that formation of intermolecular hydrogen bond results in the shifts of absorption bands. The shift depends from type of electronic transition. The investigation of the nonriged molecular complexes is important for atmospheric spectroscopy purposes.

The energy of a state, $^{2s+1}\Gamma$, arising from the molecular open-shell electronic configuration r^N, was described in the restricted open-shell Hartree – Fock (ROHF) method.

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A1-13

ENHANCEMENT OF THE FLUORESCENT METHOD PRECISION OF THE IODINE-129 DETECTION IN AIR

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Results of investigations of ^{129}I and ^{127}I isotopes of molecular iodine fluorescence within visible spectral range (500–700 nm) are reported. The goal is in improvement of the fluorescent method of the global radionuclide iodine-129 concentration determination in the atmosphere, increase of accuracy and sensitivity of its detection in the mixture with iodine-127.

The results of investigation allow us to make the following conclusions

1. Proper choice of definite spectral lines allows one to increase the limiting ratio of the concentrations $^{129}I/^{127}I$ at which the determination of the iodine-129 concentration with a precision of 10^{-5} is possible what is about an order of magnitude better comparative to the available results.
2. In accordance with character of the challenge, one may choose the iodine-129 absorption lines which correspond to the best sensitivity or the best accuracy of detection of its concentration in mixture with the iodine-127.
3. The obtained results can be more than an order of magnitude improved by increasing the temperature of the iodine vapors
4. When detecting the iodine-129 in mixture with iodine-127 in the atmosphere, it is reasonable to lower the pressure in the gas mixture to about 50–100 Torr. Under these conditions, the maximum sensitivity and accuracy of the iodine-129 concentration determination in its mixture with iodine –127 is gained

The obtained sensitivity of the iodine-129 concentration determination is at the level of 10^8 см$^{-3}$. This allows us to conduct real-time ecological monitoring of this isotope at the MPC level in the natural atmosphere.

This work is supported by the Ministry of General and Professional Education of the Russian Federation (the Grant for investigations in the field of environmental protection and human ecology).

A1-14

COLLISIONAL PREDISSOCIATION, VIBRATIONAL RELAXATION AND COLLISIONAL BROADENING OF THE LEVELS OF THE B STATE IN I_2 EXCITED BY 633-NM RADIATION OF A HE-NE LASER

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Detection of iodine-129 global radionuclide in the natural atmosphere is very important problem with respect to ecological monitoring of ambient medium. Applicability of the laser-fluorescent method to the real-time measuring of this isotope concentration using the He-Ne laser (0.63 mm) as the radiation source was earlier shown to be promising. But amount of data connected with finding the constants of rate and cross-sections of radiative and nonradiative relaxation of the I_2 states excited by the laser radiation, is now insufficient for prosperous use of this method.

This work reports on the experimental investigations of principal processes determining the quantum yield of the molecular iodine fluorescence – collisional predissociation (1), vibrational (2) and rotational (3) relaxation of excited vibrational-rotational levels of I_2 electron B-states

$$I_2^*(v';J') \xrightarrow{M} I + I \qquad (1)$$

$$I_2^*(v';J') \xrightarrow{M} I_2^*(B;v'\pm\Delta v';J') \qquad (2)$$

$$I_2^*(v';J') \xrightarrow{M} I_2^*(B;v';J'\pm\Delta J') \qquad (3)$$

In addition, the collisional broadening of I_2 absorption lines in pressure range 0–760 Torr and temperature range 200–600 K were studied.

We have determined the unknown earlier values of absorption cross-sections, rate constants for these processes, linewidths, and the constants of collisional broadening for many gases, which are constituents of the atmospheric air and differ by their physical-chemical properties: He, Ne, Ar, Xe, H_2O, O_2, N_2, CO_2, and O_3.

The obtained results allow one to significantly improve the accuracy of the laser-fluorescent method of determining the iodine-129 concentration in the natural atmosphere.

This work is supported by the Grant of the Ministry of General and Professional Education of the Russian Federation for investigations in the field of environmental protection and humans ecology.

A1-15

ANALYSIS OF WATER VAPOR ABSORPTION SPECTRUM IN 5ν + δ REGION

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New analysis of water vapor absorption spectrum for 16500–25250 cm^{-1} has been conducted. This spectral range corresponds to transitions to resonance poliad including the vibrational states 331, 213, 411, and 312. The identification of the spectrum is conducted, the energy levels are defined, and the estimates of rotational, centrifugal, and resonance states, as well as parameters of efficient dipole moments are obtained. The role of resonances of high order in formation the H_2O spectra in the Visible is under discussion.

A1-16

SOME FEATURES OF THE LINE-BY-LINE TECHNIQUE FOR THE SPECTRA CALCULATIONS OF H_2O AND MOLECULAR COMPLEXES WITH H2O IN A REAL ATMOSPHERE

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The water vapor absorption spectrum should be taken into account with high accuracy and spectral resolution in the problems of studying and sensing the structurally nonrigid molecular complexes including the H_2O molecules and ecologically hazardous traces of atmospheric components of anthropogenic origine. But the spectroscopic databases (GEISHA, HITRAN), commonly used at the present time, as well as the available models of the radiation continual absorption by water vapor (CKD, RSB) are lacking the required accuracy and fullness for solving these problems. Recently, some works begin to appear in the literature [1, 2] treating the H_2O absorption spectrum on qualitatively new basis, what allows much better consideration of its structure.

The possibility of these new data application to improving the line-by-line models of the radiation propagation in the real atmosphere is discussed in this work. The particular attention is paid to application of the models to calculating the H_2O molecular spectra and molecular complexes with the H_2O participation under conditions of the real atmosphere near industrial objects. The main result of this work will be the mathematical models and computer codes for solving these problems.

This work is supported by the Russian Foundation for Basic Research (grant № 05–64919).

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A1-17

TECHNICUE FOR STUDY OF VIBRATIONAL-TRANSLATION RELAXATION IN MOLECULE GASES USING SPECTROPHONE

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New technique for measurement of vibrational-translation (VT) relaxation time of the excited molecules using the spectrophone is presented in the paper. Experiments with a photo-acoustic cell of large diameter (d = 20 cm) and calculations have shown a decreasing of spectrophone sensitivity with reduction of absorbing gas pressure in absence of deactivation channel of molecules excited vibrationally on the wall of photo-acoustic cell. For a short laser pulse with duration tp $\ll$ tvT (tvT is vibrational-transition relaxation time) an excess point was observed in the curve of spectrophone sensitivity as function of pressure P. For this point P = Po the simple equation c*tovT/Po ~ r is valid, where c is the sound velocity, tovT is the time of VT-relaxation at 1 Torr pressure, and r is the radius of laser beam. The value tovT = $4*10^{-9}$ s·atm was found for collisions H_2O–H_2O after measurements carried out for water vapor absorption line 694.215 nm in n3 band by the use of Q-switch ruby laser (tp = 50 ns) over the pressure region 0–10 Torr. This value is in a good agreement with data of Ref. 1 obtained by other technique.

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A1-18

ON SPECTRAL LINE SHAPE IN THE 4.3 MICRON CO_2 BAND

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The theory of spectral line wings, in which the line shape is found as an asymptotic variant of the general quantum expression at large frequency shifts, remains the most adequate instrument for studying the line wings shape in IR spectra. One of its advantages is a possibility to describe theoretically temperature dependence of the absorption coefficient in line wings based on definite physical ideas on collisional interactions of molecules.

The parameters of the line shape expression describe the quantum potential of intermolecular interaction. These parameters, entering into the potential approximations by various summands $\sim C_a/R^a$ at different intervals of the potential curve, can be found from comparison with experimental data on the absorption coefficient. As the rule, the experimental data are compared in definite frequency intervals with definite summands C_a/R^a so that the corresponding parameters can be found independently in various intervals. One and the same experimental data therewith are described equally adequately by various sets of a and C_a. This ambiguity, in principle, can be eliminated, if to found the parameters by the nonlinear least squares method from the whole universe of the available experimental data.

The above-mentioned parameters were found by us for CO_2 band of 4.3 mm for various spectral ranges and temperatures. But the shape suitable for all possible situations remains to be found. In this work we try to use the available data on absorption in order to found a unique set of parameters describing the total amount of experimental data.

A1-19

SHIFTS OF THE $NU_2 + NU_3$ BAND OF H_2O DOUBLET LINES, INDUCED BY N_2, O_2, AR AND HE PRESSURE

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The pressure induced shifts of the water vapor doublet lines in the $\nu_2 + \nu_3$ band due to collisions of H_2O moleculas with quadrupole moleculas (N_2 and O_2) and with atoms of noble gases (Ar and He) were studied in spectral regin 5000–5600 cm^{-1}.

The data on lines shifts coefficients have been obtained from analisys of H_2O–N_2', H_2O–O_2, H_2O–Ar and H_2O–He absorption spectrum, recorded with help BOMEM DA3.002 Fourier-transform spectrometer with spectral resolution of 0.007 cm^{-1} and optical path length of 84.05 m.

The treatment of the data obtained have revealed, that the shifts of the doublet lines by the nitrogen, oxygen and argon are negative but in the case of the helium the spectral lines move towards each other.

The results obtained will be discussed.

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A1-20

THE HDO ABSORPTION SPECTRA ANALISIS IN 6000–7000 CM^{-1}

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The HDO spectra have been recorded at room temperature with a high resolution Fourier-Transform spectrometr and multipass cell with an absorption path length of 240 m. The HDO spectrum was recorded between 6000–7000 cm^{-1} at pressures of 5.8 mbar and 0.21 mbar. The resolution used was about 0.01 cm^{-1}, the relative uncertainty in line positions was approximately ± 0.0002 cm^{-1}. The present analysis of the HDO lines includes the line assignment of five bands (101)–(000), (021)–(000), (050)–(000), (210)–(000) and (130)–(000), found in the spectrum, the determination of the energy levels, and fitting rovibrational constants Fermi and Coriollis-type interaction parameters made better than in Ref. 1.

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A1-21

EFFECTIVE HAMILTONIAN FOR VIBRONIC COUPLING ANALYSIS IN CH_2

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The methylene (CH2) is an important molecule in hydrocarbon combustion. It also plays the important role in mechanism of the formation and reduction of nitrogen oxides, in the formation of soot.

The methylene has two low-lying electron states: the triplet ground $\tilde{X}^3B_1$ and metastable singlet $\tilde{a}^1A_1$ states. The vibration-rotation energy levels belonging to $\tilde{a}^1A_1$ electronic state are determined from the transitions between the states $\tilde{b}^1B_1 \leftarrow \tilde{a}^1A_1$ which have many absorption bands in the region 10000–22000 cm^{-1}. This spectrum has been studied in many papers however because of strongest perturbation of levels by the triplet ground state the most of absorption lines have remained unassigned.

In the present report one of the possible methods of line identification is present – method of effective electronic -vibration-rotation Hamiltonian, the nonzero coefficients of the effective Hamiltonian resonance part are determined from traditional symmetry considerations. CH_2 molecule has a low potential barrier to linearity and strong centrifugal effects for this reason we have used the regrouping of the perturbation theory series and some summation methods of divergent series to calculate rotation-vibration energy levels.

The result of this communication – effective Hamiltonian in the nonpolynomial representation suitable for analysis of strong centrifugal effects and spin-orbit interactions.

This work is supported by the Russian Foundation for Basic Research (Grant No. 99–03–33210).

A1-22

THE INTRACAVITY LASER SPECTROMETER FOR PLASMA ABSORPTION ANALYSIS

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The radicals such as CH, CH_2, C_2, C_3 play a important role in the radiation absorption in the upper atmosphere, combustion processes, astrophysics, but there is no required information about the mechanism of their formation. Many radicals absorb radiation in the near infrared region and on the other hand Nd^+ glass laser and the laser on Sa : Ti crystal work in this region and are convenient for spectra measurements.

In the report the intracavity Nd^+ glass laser spectrometer and the highly sensitive recording system of radiation spectra are presented. The system allows to record weak absorption spectra with high threshold sensitivity and to monitor the molecular composition of gas mixture using the emissiom spectra in the visible and ultraviolet spectral regions with the time resolution of 25 ns. The system testing was made using the emission and absorption spectra of the first positive system N_2.

This work was supported by the Russian Foundation for Basic Research (grant N 99–03–33210).

A1-23

ANALYSIS OF THE VIBRATIONAL DEPENDENCE OF THE SHIFTS AND HALF-WIDTHS OF SPECTRAL LINES

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Theoretical vibrational dependence of half-widths for vibrational-rotational = 2 + –N_2 lines within the bands nn2 (n = 0, 1, ..., 5) on quantum number V_2 of the bending vibration is investigated. It is found the monotonic narrowing for spectral lines = 2 + –N_2 by 15–35% compared with the half-widths within rotational band takes place. It is shown the monotonic decreasing of half-widths is mainly caused by Dk-effect. Vibrational dependence of the shifts for vibrational-rotational = 2 + –N_2 lines within the bands nv2 (n = 0, 1, ..., 5) on quantum number V_2 of the bending vibration is analyzed. It is found the changing of the shift sign and its value 2–3 times takes place. It is shown the oscillating shifts are caused by Dk-effect, the varying of mean dipole moment and polarizability, when bending vibration V_2 is excited. Mean polarizability of H_2O molecule depending on vibrational quantum numbers is investigated. Serial formula for mean polarizability is proposed:

$$a = a_0 + a_1 V_1 + a_2 V_2 + a_3 V_3.$$

Coefficients a_1, a_2, a_3 are determined by the solving of inverse problem using the measured line shifts. Intermolecular potential for colliding particles HF–Ar depending on vibrational quantum number V is analyzed. It is shown the shifts for HF–Ar spectral lines are increased by 10–15% for the vibrational state 02 compared with ones for the rotational state.

A1-24

COMPARATIVE ANALYSIS FOR DETERMINATION OF FOURIER-TRANSFORM SPECTROMETER APPARATUS FUNCTION

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Recently, it has been possible to determine the apparatus function for the Fourier transform spectrometer when the apparatus function width is of the same order of magnitude as the doppler one in the 5 micrometer region. This allows analysis of the pressure broadened absorption line profiles and has been used to reveal the deviations from the Voigt profile.

Nitrogen broadened H_2O lines were studied in 1850–2200 cm^{-1} region at different pressures of N_2 = 0–400 torr. H_2O spectra have been measured by the Furier transform spectrometer of Paris University with a spectral resolution of 0.005 cm^{-1}.

A few models of apparatus function as a sum of gaussians are produced. The apparatus function is defined by fitting the convolution apparatus function models and gaussian to experimental profile of lines CO. The fitting was produced to transmition spectrum.

We have shown in our study that two gaussian model does sufficiently good results. And apparatus function is constant in 1850–2200 cm^{-1} region.

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A1-25

REMESUREMENTS OF N_2 BROADENING OF RESOLVED AND UNRESOLVED DOUBLETS IN THE H_2O (010)–(000) BAND

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Nitrogen broadened H_2O lines of (010)–(000) band were studied in 1850–2200 cm^{-1} region. The measurements were made with the Furier transform spectrometer at different pressures of a sample ($P(H_2O)$ = 0.366–12 torr, $P(N_2)$ = 0–400 torr) with the spectral resolution of 0.005 cm^{-1}.

Resolved and unresolved H_2O doublet lines near 2000 cm^{-1} were processed with help of a theory taking into account an apparatus function of the spectrometer and both line narrowing and mixing. The apparatus function was determined as a sum a few gaussians.

The pressure line broadening and line narrowing parameters were obtained. The observed difference in pressure broadening coefficients of the concidered doublets and nearby singlet lines was explained on the bases of the developed theory.

It was found that the line mixing plays less significant role than the line narrowing for all considered doublets.

The authors acknowledge the support by Russian Foundation for Fundamental Research (Grant No. 98–02–16375).

A1-26

WATER VAPOR ABSORPTION SPECTRUM BETWEEN 13500–13700 CM^{-1}

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Investigation of the weak water vapor lines is of interest in view of atmospheric radiation budget problems. In particular, weak lines can noticeably increase the total atmospheric absorption in the near IR or visible region, and this additional absorption should be taken into account together with other factors related with radiation propagation in atmosphere.

Water vapor absorption spectra were recorded between 13500–13700 cm^{-1} using a laser spectrophotometer employing a long-base cell (30 m) and alexandrite laser. Spectrum width of the emitted radiation was less then 0.005 cm^{-1}, optical path was 1200 m. Measurements of water vapor spectra were performed at pressures 4.3, 6.85, 7.47, 7.9 torr of water and at air pressure of 100, 200, 400, 761.5 torr, respectively. Line positions, intensities and broadening coefficients were determined by fit of the Voight profile parameters to the observed transmittance values.

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A1-27

CH_4 R3 LINE OF $2N_3$ BAND BROADENING AND SHIFT MEASUREMENTS

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A laser spectrometer with a room temperature diode laser near 1.65 μm is applied for the measurements of the absorption line contour parameters (collisional half-width and shift) of the CH_4 R3 line of $2n_3$ band vs. air and noble gases (He, Ne, Ar, Kr, Xe) pressure.

The spectrometer includes two absorption cells. The Helmholtz resonant photoacoustic cell (10 cm length) and multipath White cell (10 meters optical way length) provide the simultaneous recording of the R3 line Doppler profile in pure CH_4 (White cell) and collisionally broadened profile of the same line in a binary mixture of CH_4-noble gas under varying pressure.

To determine the broadening and shift coefficients of the unresolved contour of R3 line and also of its F1, F2 and A1 components, the Voigt profiles of these overlapping components were fitted with an observed profile of the triplet.

The values of the broadening and shift coefficients obtained for unresolved R3 line are tabulated below together with the corresponding uncertainty.

For the components of the R3 triplet we have also obtained the values of the broadening and shift coefficients also. They are for example for air g $(F_1) = 0.065(5)$ $cm^{-1}.atm^{-1}$, g $(F_2) = 0.063(7)$ $cm^{-1}\cdot atm^{-1}$, g $(A_1) = 0.061(5)$ $cm^{-1}\cdot atm^{-1}$ and d $(F_1) =$ $= -0.0079(26)$ $cm^{-1}\cdot\cdot atm^{-1}$, d $(F_2) = -0.0080(20)$ $cm^{-1}\cdot atm^{-1}$, d $(A_1) = -0.0107(23)$ $cm^{-1}\cdot atm^{-1}$. Values in bracket represents the one-sigma standard deviation.

Perturber	Air	He	Ne	Ar	Kr	Xe
g ($cm^{-1}\cdot atm^{-1}$)	0.062 ± 0.003	0.042 ± 0.004	0.033 ± 0.002	0.052 ± 0.001	0.056 ± 0.003	0.070 ± 0.005
d ($cm^{-1}\cdot atm^{-1}$)	-0.0110 ± 0.0010	$+0.0023 \pm 0.0002$	-0.0005 ± 0.0002	-0.0113 ± 0.0011	-0.0151 ± 0.0006	-0.0194 ± 0.0012

The obtained results are discussed and compare d with analogous data for another CH_4 lines.

A1-28

STUDY OF VIBRATION-TRANSLATIONAL RELAXATION OF MOLECULES O_3 (N_3) IN BINARY MIXTURES WITH MOLECULAR AND INERT GASES

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The study of the vibrational-translational (VT) and vibrational-vibrational (VV) relaxation of O_3 caused by collisions with molecules and atoms are actual for the NLTE problem in upper atmosphere.

The VV and VT relaxation rate constants for (100, 010, 001) states of O_3 were determined from the phase shift of the photoacoustic signal relative to the amplitude-modulated radiation of the CO_2 laser in Ref. 1.

In this paper the alternative version of the instrument signal processing is realized the photo-acoustic signal phase shift was determined directly from the solution of balance equations for the three levels model of O_3.

The least square method was applied to fitting the calculated and observed data on the phase shift modulation frequencies 1000 and 2000 Hz.

The vibrational relaxtion rate constants are redefermined for the binary mixtures of $O_3 - N_2$, $O_3 - O_2$, $O_3 - Ar$ and compared with these obtained earlier in [1] and another literature data.

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A1-29

WATER VAPOR HOT BANDS IN 1.9 MM REGION

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The intensities of the water vapor hot bands were estimated in 4540–5851 cm^{-1} spectral region. The hot bands in this spectral range are due to transitions from the first excited vibrational state to the vibrational states of the first hexad of the interacting vibrational states (101), (021), (120), (200), (002), and (040). The line centers were calculated by the efficient Hamiltonians method using G-functions. Parameters of the efficient dipole moment were estimated based on the values of the dipole moment function derivatives for water molecule obtained earlier by the author.

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A1-30

INTERPRETATION OF HEATED WATER VAPOUR SPECTRA BASED ON THE INFORMATION SYSTEM HOTGAS

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The recent experiments on high-temperature water vapor spectra need the theoretical analysis and processing in order to obtain new information on intramolecular interactions and dipole moment of a molecule. The relative values of HF-line intensities are recorded in the experiments; but their absolute values practically have never been treated.

In this report we propose to identify the H_2O high-temperature spectra with the help of HOTGAS database. (Proceedings SPIE, 2000, v. 4063. P. 299–302). Since the experimental values of the HF-levels energy are used in the system, the identification presented by the system was chosen as the basis for analysis of the experimental spectra intensities. By means of the mean square method, the relative values of the intensity obtained experimentally were transformed into absolute ones. We have studied the intensities of pure rotational transitions and lines of fundamental band ν_2, as well as have found the constants of F-factor responsible for HF-interactions in the HF-lines. The prediction capability of the procedure, transforming the relative values into absolute ones, was tested using the experimental data, which did not take part in the experiment.

A1-31

DETECTION OF NONCLASSICAL LIGHT IN REMOTE SPECTROMETER SCHEME

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In precision spectroscopy, the quantum noise of a source and spontaneous noise of an absorbing medium are the main factors limiting the accuracy and sensitivity. The light sources with lowered quantum fluctuations are by this time realized experimentally. The currently central problem is studying the noise properties of radiation after its interaction with extensive macroscopic medium.

In this work, the detection formulae have been obtained for local description of nonclassic light interaction with extensive macroscopic medium under sensing. The wide absorption band detector is simulated by a set of similar two-level cold atoms.

The expression has been found for photocurrent spectrum of a set of nonclassic sources located at the linear medium output. In this case a spontaneous component contributes into the whole band under observation. An interesting peculiarity appears for the variant of nonlinear spectroscopy using the two-photon or parametric transforms. When propagating through the medium under sensing, the light keeps its quantum properties, and the conjugated modes therewith can be augmented.

The obtained expressions are a modification of the detection formula for the spectrometer local (intracavity) schemes.

A1-32

WEAK H-BOND COMPLEXES

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The present study focuses on the weak H-bonded $(H_2O)_n(HCL)_m$ complexes. One of the most recent trends in vibrational spectroscopy has been directed towards intermolecular interactions and motions. A range of spectroscopic techniques including molecular beam electric resonance, pulsed-nozzle Fourier transform microwave, and infrared laser are capable of providing valuable information concerning the structure and properties of a large number of H-bonded complexes. The intermolecular modes can be studied directly by far infrared, low-frequency Raman, and incoherent inelastic neutron scattering spectroscopy. However, the low concentrations of these complexes and interference from the very intense rotational spectra are occurring in the far–IR regions makes reliable interpretation of the spectra of molecular complexes very difficult task. A complete set of intermolecular vibrations has been determinated for only a very limited number of H-complexes. The quantum mechanical ab initio calculations can be of great use in assisting experimentalists with band identifications and elucidation of general principles. Structure, energetics, and vibrational spectrum of row of $(H_2O)_n(HCL)_m$ complexes were studied in this work. Ab initio calculations were carried out using 6–31G** basis set containing polarization functions on all atoms. Complete optimization of the geometry was performed at the SCF level with the gradient procedures and Newton-Raphson method. The basis set superposition error (BSSE) was calculated.[1] The vibrational analysis was done. Two groups of vibrational frequencies were determinated: intramolecular and low intermolecular frequencies. The interaction energies of these complexes were calculated and stable complex configurations were found.

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A1-33

INTERFERENCE OF WATER VAPOR LINES. CONNECTION OF INTRAMOLECULAR AND INTERMOLECULAR EFFECTS

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Experimental and theoretical study of water vapor lines interference as well as connection of intramolecular resonances with non-linear dependence of a line shift on pressure has been performed.

The water vapor spectra between 5000 and 6000 cm^{-1} broadened by N_2 pressure were measured using the FT-spectrometers of NIST, USA at buffer gas pressures from 148.5 to 3800 Torr. The measurements were made for lines of (011)–(000) and (110)–(000) bands with spectral resolution 0.007 cm^{-1} .

The theoretical analysis was made using formulas developed recently by Thibault et al [1] taking into account the line mixing effects within the perturbation approach. The non-diagonal elements of relaxation matrix were calculated in the frames of impact theory using the formulas given by Cherkasov [2], only leading dipole- quadrupole interaction was taken into account. The calculations predicted that the line mixing gives negligible contribution into the shift for most of lines for H_2O–N_2 system, but it was found some lines, where line coupling is noticeable.

The crucial point is connection of mechanism appearing from abnormal intramolecular interactions resonances of different types with coupling lines mechanism appearing as a result of buffer gases molecules influence .

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A1-34

ON THE VIBRATIONAL DEPENDENCE OF MEAN POLARIZABILITY, HALF-WIDTHS AND SHIFTS FOR QUASIRIGID MOLECULES

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Within the framework of pressure broadening theory the new conception of the treatment of vibration-rotational interactions in polyatomic quasirigid molecules have been introduced. According to this conception the vibrational dependence of mean polarizability, half-widths and shifts of quasirigid molecules are described at the representation of effective molecular Hamiltonian in the form $H^{eff}_{vr} = H^{eff}_{vib} + h_{vr}$. Vibrational motion are separated from vibration-rotational one within effective Hamiltonian using limiting ordering schemes of virration-rotational interactions proposed in [1]. Pade approximants for vibrational dependence of mean polarizability, half-widths and shifts of H_2O molecule have been developed for the first time. Random resonances of Darling-Dennison type affect additively the vibrational dependence of mean polarizability, half-widths and shifts of quasirigid molecules. Thus, representation of effective Hamiltonian in the form mentioned above explaines completely the vibrational dependence of mean polarizability, half-widths and shifts of quasirigid molecules such as H_2O.

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A1-35

ON THE ANALYTICAL PROPERTIES OF CENTRIFUGAL DISTORTION DIPOLE MOMENTS OF METHANE

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There has been considerable interest in recent years to the electric dipole moments induced in the ground and excited vibrational states of tetrahedral molecules [1]. The previous theoretical studies of this problem summarized in Ref. 2. In the contribution the singularities in rotational dependencies of centrifugal electric dipole moments of methane are analyzed by using Pade-approximant method. First diagonal Pad'e-approximant for these types of electric dipole moments for tetrahedreal molecules may be presented in the form

$$\Theta_Q F^{3,j,j}_{A_2,k',k} = \left[\frac{\left(\Theta^{xy}_z\right)^2}{\Theta^{xy}_z - 2\left(\Theta_J + \Theta_K / 3\right) J(J+1)} \right] F^{3,j,j}_{A_2,k',k}$$

where symbol Q is a Q-branch, F are Moret-Bailly 3j symbols, Θ^{xy}_z, Θ_J, Θ_K are parameters in $\tilde{M}_{03}$ and M_{05} operators [3], correspondently, of the effective dipole moment for rotational transitions. On the base of theoretically calculated in Ref. 4 Θ parameters for CH_4, J critical for first singularities on a complex J plane for centrifugal dipole moments has been estimated.

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A1-36

CYBERNETICS METHODS IN SPECTROSCOPY. AUTOMATIC FIND AND FIT OF LINES OF MOLECULAR SPECTRA

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Instrumental automatic system for initial spectra processing, lines shapes find and fit created. The system uses pattern recognition methods [1, 2], the one allow to classify crossing lines, and in addition make lines grouping for simultaneous LSE-fit using clustering analysis [3].

"Line finder" procedure give enough exact information about lines positions. This information used in fit LSE procedure as additional information. It make iteration fit process much more steady and firm.

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A1-37

ON THE EVALUATION AND ASYMPTOTIC BEHAVIOUR OF HERMAN-WALLIS FACTORS FOR MULTIQUANTUM VIBRATIONAL TRANSITIONS IN SYMMETRIC TOP MOLECULES

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Within the framework of theory of linked ordering schemes of vibration-rotational interactions in molecules [1] introduction of Herman-Wallis factors in intensities of multiquantum vibrational transitions has been presented in effective dipole moment operator by sequences of types $M_{eff} = M_{n1} + M_{n2} + M_{n3} + ...$, where $n = 1, 2, 3, ...$ [2].

Procedure of calculation of $\tilde{M}_{nm}$ have been brought to correspond with new conception of classification of intramolecular interactions [1].

The results of group-theoretical analysis of tonsorial parameters in M_{1n} ($n = 1 \div 3$) for symmetric top molecules has been presented. Generalization of these results for multiquantum vibrational transitions is analyzed [3]. The another goal of the contribution was the analysis of the ways of the construction on nonpolynomial models for Herman-Wallis factors on the base of the representation of M_{eff} in forms of infinite sequences on angular momentum operators. Some simple models for HW factors in Pade-approximant form are considered. On the base of developed and presented theory of vibration rotation line intensities in molecular spectra the conception of fitting molecular dipole moment transition of quasirigid molecules is for the first time discussed.

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A2-01

SPATIAL-TEMPORAL VARIABILITY OF THE TEMPERATURE REGIME OF SIBERIA

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It is revealed to date that mean global temperature increases last 100 years with the rate of 0.4–0.5 °C/100 years. However, the rate of the temperature increase is not constant inside the 100–year period. The spatial distribution of the warming rate also is inhomogeneous. Revealing of the reasons causing such an inhomogeneity and their consequences is very important problem for study.

This paper is devoted to the discussion of the spatial–temporal characteristics of the near–grouns temperature field in Siberia obtained on the basis of processing the data of 39 stations of observation during 1955–1990.

The analysis of the field of the long–term temperature trend has shown that the tendency of warming is observed on all territory of Siberia. The rate of the long–term trend in the analyzed period changes from 0.2 to 0.5 °C/10 years. The trend field configuration is characterized by the multi–center structure. The greatest rate of the change of temperature is observed in central and southern parts of Western Siberia. Taking into account that there are big wetlands in the central part of Western Siberia, one can not exclude that the global warming process intensifies the methane emission than strengthens the local greenhouse effect.

The amplitude of annual behavior of temperature in Siberia varies by 2.6 times, from 32.7 °C in Verkhoyansk to 12.5 °C on cape Zhelaniya. The distribution field of the amplitude of annual behavior of temperature is characterized by one center at the cold pole in Verkhoyansk with maximum value and three ridges the axes of which are oriented to west, east and south–west. The isolines of the amplitude of annual behavior are closed. On the most part of Siberia the amplitude of annual behavior linearly decreases as mean annual temperature increases. The exception are 4 stations grouped around the cold pole in Verkhoyansk. The contrary dependence is observed for these stations: the amplitude of annual behavior increases as mean annual temperature increases. It is evidence of the fact that the warming process occurs due to the increase of summer temperature.

The analysis of variability of the temperature field has shown that the fraction of the long–term trend in forming the variance of the initial series is some tenth or hundredth of percent, the anomalies form about 5% of the total variability and the contribution of seasonal behavior is 95%.

A2-02

EFFECT OF ICE CRYSTALS' SHAPE AND SIZE ON RADIATION CHARACTERISTICS OF CLOUDS

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Recent results of theoretical and experimental studies show that scattering properties of nonspherical ice particles may strongly differ from corresponding properties of spheres equivalent in area or volume. This difference significantly influences microphysical and radiation properties of crystalline clouds and, consequently, the accuracy of description of interaction between cloud fields and radiation, for example, in the models of the atmospheric global circulation and climate. To study the sensitivity of the crystalline clouds' radiation properties to shapes and sizes of ice crystals, the model of horizontally homogeneous plane-parallel layer is, as the rule, used. This model not always correctly describes the solar radiation transfer in the cloudy atmosphere because of ignoring the horizontal heterogeneity typical for realistic clouds. The goal of this work is investigation of joint action of the effects, conditioned, on the one hand, by stochastic geometry of clouds, and, on the other hand, by the crystals shape and size on the albedo, transmission, and angular distributions of solar radiation in the cloudy atmosphere.

To take into account the clouds stochastic geometry, the Poisson model of broken clouds for straight paths is used. The radiation parameters are calculated at 0.63 mm wavelength for optical and geometric characteristics of crystalline clouds, typical for middle latitudes of the northern hemisphere, using the scattering phase functions of small ice columns and plates, stochastically oriented in space (Petrushin). The calculation results are compared with those made with the scattering phase functions for (1) area-equivalent spheres and (2) hexagonal particles stochastically oriented in space (Takano and Liou).

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A2-03

THE METHOD OF AEROSOL OPTICAL THICKNESS SEPARATION INTO ABSORPTION AND SCATTERING COMPONENTS

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The method is proposed for separating the vertical optical thickness of cloudless atmosphere into components conditioned by light absorption and scattering. The method is based on the modified formula of V.A.Smerkalov[1] for the scattering aerosol optical thickness determined from observations for absolute phase function of the cloudless sky intensity in solar almucantar. As the initial

data for transforming the formula into more universal one, we used numerical results of the radiation transfer equation solution for plane-parallel atmosphere made by the spherical harmonics method.[2] The approximation relation has been resulted, which covers the spectral range 0.34–1.1 mm for the atmospheric transparency and sky intensity measurements, the range 60–80° for the Sun zenith distances, and the range 1–5 for turbidity factor variations in the spectral range of 0.55 mm. The method was approved using the experimental data obtained with the use of day sky photometer in Kirbaltabay settlement of Alma-Ata region[3] and with NASA sun photometer in Barnaul city.

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A2-04

THE INFLUENCE OF SOLAR RADIATION ON CHANGING THE SURFACE OZONE CONCENTRATION

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Results of estimating the influence of solar radiation on changing the surface ozone concentration due to changing the total ozone content are presented. Data analysis of measurements of surface O_3, CO, CO_2, NO, and NO_2 concentrations, solar irradiance, and total ozone, carried out at the TOR station and the SLS in Tomsk during 1993–1999, has shown a presence of statistically significant opposite trends in temporai series of surface and total ozone, and has not determined decreasing the concentrations of the other species as components of ozone cycles. Moreover it has not determined decreasing the solar irradiance.

It has been supposed that the influence of solar radiation on the surface ozone concentration is mainly realized in UV spectrum where a change of solar radiation affects weakly on a changing the irradiance measured experimentally. And it is known, UV radiation coming on a surface is controled by total ozone. It is supposed that the UV spectrum, where a change of solar radiation may essentially determine the generation of surface ozone, is arranged in the range of 295–310 nm. For testing this hypothesis, an estimation of relative changing of solar UV (295–310 nm) radiation due to relative changing of total ozone was made. The calculations shown that observed 11.8% growth of total ozone may decrease the photodissociate rate of tropospheric ozone by 55%. In turn, that corresponds to observed decrease of surface ozone by about 51%.

A2-05

LONG-TERM VARIABILITY OF THE GLOBAL OZONE LAYER

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For the period 1979-1999 the rate of decreasing of yearly mean global column ozone is found to be about 2.5% per decade. Such decreasing in mid- and high-latitudes of the Northern Hemisphere is strongly due to increasing of frequency and magnitudes of negative column ozone anomalies in the period 1987–1997. Increasing of column ozone to values that were typical for the middle of 1970s has been observed in mid- and high-latitudes of the Northern Hemisphere during last two years. Interannual column ozone variability in the Northern Hemisphere was largely associated with such a regional climate process as the North Atlantic Oscillation (NAO) that is known to have a hemisphere- or even global-scale influence on climate. Column ozone variability in tropics was largely associated with solar activity, quasi-biennial oscillations, and, in some regions, El Nino/Southern Oscillation (ENSO). Satellite-borne observations show that the ozone "hole" that was already clearly identified before the 1980s in the seasonal variation of column ozone over Antarctica at latitudes higher than 60 S, continues to increase or has reached its maximum (in 1999 it was only slightly smaller than in 1998). Cross-correlation analysis of column ozone deviations shows that formations of ozone anomalies in both hemispheres are co-ordinated in global scale. The reasons of ozone changes are discussed.

A2-06

MODELLING OF THE OZONE VERTICAL DISTRIBUTION

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A system of differential equations for vertical distribution of ozone concentration and temperature is derived based on the condition of maximum entropy in atmospheric column of some gas admixture absorbing the radiation

$$z'' + (z')^2 * Fz(x, z) = 0; \quad (1a)$$

$$x'' + (x')^2 * Fx(x, z) = 0; \quad (1b)$$

where z(h) – is the barometric height; x(h) is the ozone in a column above height h with inverse sign: F(x, z) is the exponent (index) of Bouger exponent accounting for the square (Forbs) members with respect to x and $p = p_0 * \exp(-z/H)$, Fx и Fz are its partial derivatives with respect to x and z, correspondingly. H is the height of homogeneous atmosphere; sign' denotes a differentiation with respect to the height.

The system (1) is a set of Euler-Lagrange equations for functional of complete entropy in the column, and its first integral (the condition of the entropy constancy with respect to the height) is

$$x' * z' * \exp[F(x, z)] = \text{const}. \quad (2)$$

The derived model was tested using the database of the ozone sensing, including more than 20 thousands of measurements, and has shown a good agreement with the experiment. Mean square relative error for integral ozone was 0.2%, for concentration (x') – 3.5%. Mean square absolute error for absolute temperature (1/z') was 0.8 K..

The model failed (the system (1) became unstable) only for spring antarctic measurements at stations Seova and Amundsen-Scott, where the values of integral ozone were lower than 150. The reason is in the fact that for the system with variable amount of particles the entropy essentially differs from the values given by the left side of formula (2).

At the same time this result demonstrates that the ozone within the range of standard sensing transforms into a system with variable amount of particles (i.e. becomes prone to chemical destruction) only at sufficiently low integral values, what in turn testifies to significant contribution of pure dynamical processes into initial phase of evolution of the phenomenon "antarctic ozone hole".

A2-07

INFLUENCE OF VARIABILITY OF CH_4, N_2O, AND FREON CONCENTRATIONS ON LONGWAVE RADIATION FLUXES IN THE EARTH'S ATMOSPHERE

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The greenhouse effect in the Earth's atmosphere is associated not only with increase of carbon dioxide concentration but also with increase of CH_4, N_2O, and freon amount. In this report the problem of necessity of taking into account these gases in modern climatic models is discussed. The solution of this problem depends on the accuracy of radiation models, what is connected with availability of qualitative spectroscopic information as well as corrective parameterization of the radiation transfer equation.

Statistical approach is used for investigation of the longwave fluxes sensitivity to the uncertainties in the spectroscopic line parameters. The results show that the main source of the uncertainties of radiation model is systematic error in continuum coefficient of water vapor and uncertainty of band intensity and linewidth.

In this report we investigate the influence of variability of CH_4, N_2O, and freon concentrations on radiation process in the Earth's atmosphere. Various meteorological conditions are used in the modeling. The investigation of radiation regime of the troposphere has received much consideration. It is shown that contribution of CH_4, N_2O, and freon at their background concentration into longwave fluxes is greater than the uncertainties defined by the error of spectroscopic information. Nevertheless, the sensitivity of longwave fluxes to double concentrations of these gases is less then their sensitivity to uncertainties in absorption coefficients of the water vapor continuum.

A2-08

TRANSMITTANCE PARAMETRIZATION IN THE EARTH ATMOSFHERE RADIATION TRANSFER PROBLEMS

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Increase of the greenhouse gases concentration such as CO_2, CH_4, N_2O, and Freon is a factor of the climate global change. Doubling of their concentration can result in 1% change of the heat radiation fluxes. Therefore, the accuracy of the transfer equation solution for the problems of climate modeling should be at least no worse than 1%. Only the standard method meets this requirement, but its numerical realization is very cumbersome. At the same time, the specificity of the problems of the atmosphere global circulation needs simple and efficient models of heat radiation, the base of which is the transmission model of atmospheric gases.

In this report we generalize the results of elaborating the approach to creation of the transmission models conforming to the requirements of exactness and efficiency. The approach is based on the Laplace transform of the transmission spectrum allowing us to replace the fast-oscillating function of the absorption coefficient for N spectral lines by the smooth function equivalent to the absorption coefficient of one line and the absorption spectrum of which is equal to initial spectrum of N lines.

The equivalent absorption spectrum is approximated by a short series of orthogonal exponential functions.

Representation of the transmission functions as exponential series has some advantages over the model methods. 1) The exponential series allows us to fully take into account the interaction between molecular absorption and scattering. They are the

most efficient in solving the radiation transfer equation by the Monte-Carlo method, because in this case it is not necessary to approximately take into account the molecular absorption. 2) None of the models can provide the accuracy comparable with that of this method. 3). For the exponential series, the multiplicative representation of the transmission function is held just as in the case of the method of direct computation. 4) The parameters of the exponential series are easily and naturally computed based on the direct computation method.

A2-09

FORWARD MODEL AND RETRIEVAL ALGORITHM DEDICATED TO NADIR AND LIMB VIEWING MEASUREMENTS. COMPARISON WITH THE LINE-BY-LINE LPMA ALGORITHM

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Remote sensing of atmospheric state parameters (such as temperature and mixing ratio profiles, trace gas column amounts) requires fast and accurate forward model radiative transfer calculations. Application of commonly used line-by-line (LBL) models to calculate atmospheric spectra and simulate actual measurements provides high accuracy but is often too much time consuming. The wide spectral regions covered by a number of satellite and balloon instruments need an efficient forward model algorithm. One way to decrease the calculation time is to use pre-calculated absorption cross sections with a satisfactory accuracy for an optimised grid of wavenumber, temperature and pressure. This database (known as look-up-table) is to be used in processing spectra of satellite-borne instruments like IMG and ILAS, of the balloon-borne LPMA instrument, and of future satellite instruments (IASI, ACE, etc.). The use of a look-up-table on a wide wavenumber interval and for a large number of trace gases is efficient when a good interpolation scheme and an appropriate storage of the data are chosen. Comparison of data processing results obtained using the look-up-table technique with results obtained by the direct line-by-line LPMA algorithm will be presented and discussed. The potential for balloon spectra retrievals will be illustrated.

A2-10

THEORETICAL AND EXPERIMENTAL ANALYSIS OF OPTICAL ABSORPTION SPECTRA OF ALGAE (ON EXAMPLE OF SPIRULINA PLATENSIS)

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Phytoplankton plays a dominating part in formation of light field of the ocean; energy transfer significantly depends on the absorption.

In this report, the dependence of the algae optical absorption spectra on phytoplankton microstructure parameters (size- and shape-distribution) is analyzed theoretically in order to experimentally determine the specific indices of absorption for the algae pigment mixture using the Spirulina platensis as the example.

We have determined the specific indices of absorptin for the mixture of photosynthetically active pigments of the algae in the visible spectral range (400–700 nm) and have presented their point estimates.

We also estimate the degree of chlorostrata destruction under exposure to mechanical action.

Applicability of the obtained results to express estimation of the algae monoculture concentration (boimass), the algae pigment composition variation under action of outside conditions, and the physiological state of cells are under discussion

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A2-11

ABSORPTION OF THE SOLAR RADIATION IN THE ATMOSPHERE IN CENTRAL ASIAN REGION

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Daily global solar radiation in the top atmospheric boundary has been estimated in different months and seasons in latitude 30–45° N. In May–June, due to increase of day time length, an increase of the global solar radiation flux at 33–43° N was observed.

It is shown that the latitude variability of radiation balance components near the ground surface is conditioned by the atmospheric transparency and cloudiness. The high clouds cause 10–15% decrease of the global solar radiation, medium-layer clouds – 15–20%, and low clouds – 25–30% one. The medium-layer clouds (8–10 cloud amount) cause 25% decrease of the direct global radiation and low clouds – 35% decrease comparative to the cloudless state of sky. The dependency of the radiation balance components on various forms of cloudiness in these latitudes is presented.

In the Central Asia region, solid aerosols are noticed to add 10–15% decrease of the solar radiation.

A2-12

ABOUT SUN PHYSIKS AND IT'S IMPACT ON SOLAR-TERRESTRIAL CONNECTIONS MECHANISMES

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The problems of physics of the Sun, our luminary and main source of energy on the Earth, have long been of interest to the scientists. There is a rich variety of opinions on the problem, often rather contradictory, due to imperfection of the present-day instrumentation and, consequently, instrumental observations.

The current nature of the radiation and divisibility of an electron are hypothesized in our report, as well as some materials are proposed to prove these suppositions.

The prospects of investigation of the solar-terrestrial connections mechanism in the interests of qualitative improvement of the intermediate-term and long-term climatic forecasts occupy a significant part in our report. The Sun physics investigations including the speculations of new hypothesis and corresponding theories are favourable for deep insight into the most important mechanisms of the energy transfer. The presented arguments, to our opinion, adequately describe well-known physical processes, if the hypothesis of electron divisibility is accepted.

A2-13

INTERESTING CLOUD FEATURES SEEN BY INFRARED COMPLEX 3.7 MKM IMAGES

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Ground - based measurements of radiances clouds at three wavelengths – visible (0.8 μm) and infrared (3.7 and 11 μm) - were made during autumn 1999 year at the Minsk (53° 54' N lat., 27° 35' E long., height on sea level H = 220 m) and off the Minsk (54° 15' N lat., 27° 21' E long. H = 257 m). Optical measurements were made using visible photometer and infrared complex. The daytime 3.7 μm images show for more detail clouds than the other two channels, which are normally used for forecasting purposes. The large variations in 3.7 μm radiance seen from cloud during the daytime are due to different cloud reflectances at 3.7 μm. This is a different but related effect to that reported by Eyre et al. (1984) who make use of the difference between the cloud or fog emissivities at 3.7 μm and 11 μm to detect the presence of fog and low cloud at night. A cloud scattering radiative model is used to show the sensitivity of 3.7 μm radiances to water drop size and water / ice phase, and the nearest coincident synoptic chart is given for comparison with the infrared complex images.

A2-14

TRANSMITTANCE OF FEMTOSECOND TITAN-SAPPHIRE LASER'S RADIATION ON HORIZONTAL AND INCLINED PATHS

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Femtosecond lasers generate radiation of regular mode composion, the spectral width of which is comparable with the carrier frequency and reaches several hundreds of inverse centimeters. Femtosecond laser can be used in designing the wide-band lidars, which operate on the multifrequency sensing principle. But this is connected with the problem, which requires studying the regularities of interaction between ultrashort pulses and the atmosphere as well as the methods of accounting for molecular and aerosol attenuation on propagation of such pulses through the atmosphere.

Transmission of the femtosecond titanium-sapphire laser radiation with wide multimode spectrum, covering the spectral range of 730–980 nm, along horizontal and inclined paths is examined taking into account the absorption by H_2O, O_2, HF, HCl, and other molecules at variation of width and mode structure of the radiation spectrum.

Table 1 presents the calculation results for the path of 1 km length with homogeneous distribution of the temperature, pressure, and concentration of natural molecular components of the atmosphere for mid-latitude summer model and bell-shaped distribution of the generated modes.

Table 1. Transmission of femtosecond laser radiation on horizontal path

Frequency range, $см^{-1}$	Intermode interval, $см^{-1}$	Amount of modes	Transmission
10200–13200	0.01	300000	0.924
10200–11200	0.01	100000	0.697
11200–12200	0.01	100000	0.987
12200–13200	0.01	100000	0.977
10200–13200	0.1	30000	0.924
10200–11200	0.1	10000	0.676
11200–12200	0.1	10000	0.989
12200–13200	0.1	10000	0.983

The conducted calculations show that the difference between the transmission values at possible variations of spectrum width, central frequency, and interval between neighboring modes may reach 25%.

A2-15

SOLAR REMOTE FOURIER TRANSFORM INFRARED SPECTROSCOPY FOR DETECTING CO_2 PROFILE IN LOWER TROPOSHERE

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In the report is discussed what spectral band should be chosen for Fourier Transform Spectroscopy (FTS) measurements of direct solar radiation to retrieve of the vertical distribution of gases from it. The spectrum of the Solar radiation measured above ground contains large information quantity. The FTS allows receive transmission spectra of atmosphere in wide spectral range in NIR (Near Infra Red) and IR. In NIR and IR spectral regions there are bands of absorption of the majority of atmospheric gases (such as H_2O, CO_2, O_3 and other). From measurements of direct Solar radiation, it is possible to retrieve the information on the contents of any gases of atmosphere with an altitude (gas profile). In this paper, we analyse the rotational absorption to obtain the vertical distribution in the lower troposphere assumption a temperature profile is given.

A2-16

PASSIVE REMOTE FOURIER TRANSFORM INFRARED SPECTROSCOPY FOR DETECTING CO2 IN TROPOSHERE

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The atmospheric concentrations of many trace and greenhouse gases can be measured with Fourier Transform Spectroscopy (FTS) by the use of their characteristics narrow-band absorption in NIR or IR. Using the long-path method we can retrieve the average concentrations of any gases on distance of measurement with help of differential optical absorption spectroscopy (DOAS). Lasers systems are used for this measurements ordinary, but we suggest use the artificial source of light glowbar located on some height above the ground or on the ground. FTS instruments possess many advantages over the more conventional gas analysis systems, because has a wide spectral region of measurements with higher sensitivity and with middle or high (< 0.01 cm^{-1}) spectral resolution. It is allow retrieve not one but more gas concentrations simultaneously. In this report we demonstrate the performance of this approach to detecting atmospheric CO_2, and we will discuss the spatial and temporal resolution, sensitivity and selectivity of retrieving methods.

A2-17

THE METHOD AND DEVICE FOR ATMOSPHERIC ACTINOMETRIC PARAMETERS REGISTRATION IN THE RANGE OF 0.4-2.9 MCM IN COMPLEX METEOROLOGICAL CONDITIONS

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The lack of commercial production of up-to-date actinometric instruments retards the development of statistical actinometry. The Scientific and Production Association "Taifun" in cooperation with other organizations works out a mockup of actinometric system for simultaneous registration of hemispherical (from the whole hemisphere of sky) spectral density of radiance (SDR) and its distribution over the sky annular zones within the range of 0.4–2.9 mm with spectral resolution no worse than 1–3% of the wavelength.

The system allows one to register the direct and scattered solar radiation under various conditions including rapidly changed meteorological situation.

The mockup is created based on the Russian patent for invention № 2125250 of 21.01.99 with priority of 11.08.97.

A2-18

HEATING THE ATMOSPHERE BY PARTICLES OF URBAN AEROSOL

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A simplified method of calculating variations of the urban air temperature due to absorption of short- and long-wave radiation by particles of urban aerosol is proposed. Optical model of absorbing anthropogenic layer is composed based on the data from Ref. 1; it includes soot particles (60%),[2] dust particles (ash, cinder) (20%), and droplets of salt solutions (20%).

Within 0.55 mm spectral range its optical depth is taken as 0.4, and the probability of quantum survival – 0.7. The higher atmospheric layer is considered as free of anthropogenic particles, and its optical parameters correspond to the background model.[3]

For calculation of absorbed short-wave radiating power we use a simplified procedure[4–5]: a layer of anthropogenic aerosol is lighted by direct solar rays, sky diffuse light is formed in the top layer, and diffuse light is reflected from the underlying surface. In two latter cases the intensity of the diffuse light is taken as independent of direction.

The single scattering approximation is used in the calculations of the absorbed radiation.

Analysis of data on solution of the transfer equation for monochromatic radiation in three spectral ranges has shown the light multiple scattering to introduce 20% change into the final result.

Accounting for the latter fact, we have computed the power of the absorbed short-wave radiation at various zenith distances of the Sun and various albedo of the underlying surface based on the experimental data on fluxes of transmitted short-wave radiation.[6]

These results are added to the values of the absorbed long-wave radiation power computed under the assumption that the temperature rise of the underlying surface is 10° for the period from the sunrise to its culmination. In closing, it is shown that the radiation absorption by anthropogenic particles within 100 m layer under winter conditions results in mean rise of its temperature of about 1.5° for the period from morning to noon.

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A2-19

RADIATION TRANSFER IN HETEROGENEOUS CONVECTIVE BOUNDARY LAYER OF THE ATMOSPHERE

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Further study of inhomogeneities of the atmospheric boundary layer is impossible if the influence of radiation processes on formation of aerosol inhomogeineties of various forms is not taken into account. Investigation of scattered radiation reflected by the underground surface, conducted simultaneously with lidar sensing of atmospheric aerosol in Kalmykia, has shown the atmospheric radiation to have high spatial variability.

Within the framework of the problem we have simulated the radiation regime of individual convective cloud. All initial microphysical, geometric, and optical parameters, as well as their relations were considered accounting for properties of cumulus clouds. But setting the problem is not changed in principle, if to treat some dust cloud.

A2-20

METHODICAL PROBLEMS OF REGULAR MEASUREMENTS OF INCOMING SOLAR RADIATION

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When performing regular measurements of atmospheric characteristics, in particular, the incoming solar radiation, we must solve the following problems of methodical character: a) to determine the time observation conditions (periods, frequency, measurement duration); b) optimization of the experiment (maximum of information content with minimum of meters); c) the agreement of the instrument – methodical characteristics of the experiment with the feasibilities of automation and computer recording. To obtain the full set of standard characteristics we commonly use the three instruments (an actinometer, a pyranometer, a heliograph), and the measurements are carried out either continuously (during daytime) or as short-term measurements for given periods (further–"discrete").

The paper analyzes the errors of determination of hour and daytime radiation occurring at discrete measurements of different duration (2–40 minutes). The measurement errors are estimated based on the test real data array - the results of continuous measurements of global radiation in the vicinity of Tomsk (summer 1997). Note that discrete measurements are effective only when studying the seasonal interannual variation or when analyzing the long-term series of measurements. To determine the peculiarities of short-term variations the continuous observations must be made.

The second problem refers to the decrease of the number of measuring instruments without the loss of the required information. The results of the measurements showed that in most cases (radiation problems and atmospheric conditions) there is a need to use only one meter – a pyranometer easily adapted to computer recording. That is, having the daytime realization of the global radiation variation we can reconstruct the direct, diffuse radiation and the sunshine duration. The necessary conditions for

solving this problem are the continuous radiation recording and irregular overlap of the sun by cloudiness (most of situations). The rare in occurrence situations are of two types. At solid cloud cover the global radiation equals the diffuse radiation, and it is impossible to measure the direct radiation. In another case when the cloudless sky 24 hours a day was observed, the diffuse radiation can be determined by a traditional method, namely, by an artificial overlapping of direct radiation by a screen. The paper describes the basic principles of an algorithm based on a series of logical procedures and threshold relationships.

A2-21

RADIATION REGIME IN TOMSK REGION

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An investigation into solar radiation transformation in the atmosphere requires quantitative estimate to appreciate the radiation regime as a whole.

The goal of this work is to estimate the amount of the global solar radiation and its variability in the Tomsk region. To analyze the situation, we used the data of 24-hourly measurements of the global solar radiation (Q) and radiation balance (B) at the TOR station in 1995–1999.

The obtained results can be briefly formulated in the following way.

The yearly behavior of the global solar radiation in 1995–1999 in Tomsk region has been measured. It should be noted that at sufficiently standard annual behavior of Q, some deviations have been noted: mean income of the total solar radiation in June turned out to be less than in May; and the maximum of monthly sum of Q has shifted from June to July.

The magnitude and range of the monthly radiation variation depend on the season. In winter time (November- February) the coefficient of variation (V) of the monthly radiation changed within the limits 5–9%, and minimum variations were marked in December–January. In summer (June–August) V = 9–13%. Minimum monthly Q was recorded in June, 1995, and maximum – in July, 1998. In the transient periods (spring, autumn) the limits of the monthly variation are wider: V = 2–24%.

On the whole, in the period under treating the radiation regime in Tomsk region was sufficiently stable. Yearly magnitudes of Q remain practically constant from year to year, and the coefficient of variation of the yearly global solar radiation is 2%.

A2-22

VARIATION OF GLOBAL SOLAR RADIATION VERSUS SYNOPTIC CONDITIONS

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As is well-known, the amount of incoming solar radiation on the Earth's surface depends on a lot of factors, many of which are due to synoptic conditions.

The goal of this work is to analyze the variability of global 24-hourly solar radiation vs the type of baric formation and air mass. As the initial data we have used the 24-hourly measurements of global solar radiation at the TOR-station for 1995–1999 years and the results of synoptic maps processing for the same time.

From the whole array of data we have selected the days, when some specific type of baric formation (cyclone, anticyclone) or air mass (arctic, temperate, subtropical) dominated. Based on these samples, we have built the annual behavior of global daily solar radiation for cyclone and anticyclone and for two types of air mass – arctic and temperate.

The final results may be briefly formulated in the following way.

The amount of incoming global solar radiation in anticyclone and cyclone in the Tomsk region depends on the type of baric formation. It is on the average in anticyclone 1.8 times higher than in cyclone.

Composite dependence of the incoming global solar radiation on the air mass type during the year is observed. So, if from November to March the magnitudes of daily radiation in both air masses are close to each other, in other time the relation among them may vary (become greater or less).

A2-23

APPLICATION OF SERIES OF EXPONENTS TO CALCULATION OF RADIATION FLUXES

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Earlier the exact formulae for the coefficients of expansion into the exponential series were used by the authors in calculating the integrals with source function and absorption functions for the cases of homogeneous and heterogeneous paths. The obtaining of the above-mentioned formulae is based on the theory of the exponential series. The same approach was used in derivation of expressions for radiation fluxes. From computational point of view, the expressions for fluxes include the same expansions as in the case of transmission functions, except that they are someway weighted and ordered. Just as in the case of the transmission

functions, the resulting expansion includes a few members, although for their computation the absorption coefficient should be computed with sufficiently small step.

Based on the worked out method, we considered the computation of the radiation fluxes, conditioned by water vapor, for standard 33-layer atmosphere of mid-latitude summer within the range of 1380–1900 cm^{-1}.

A2-24

ON STABILITY OF THE ONE-DIMENSIONAL RADIATIVE MODEL WITH THE ALBEDO-TEMPERATURE RELATIONSHIP

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Simple radiation model described by the ordinary differential equations for temperature layers is under examination. Evident temperature dependence distinguishes it from traditional models and allows an application of qualitative investigation methods to analysis of the temperature altitude behavior.

Stationary states of such system (in this case the temperature altitude profile plays the role of stationary state) and the characteristics of their stability are found by solving the algebraic equations for coordinates of stationary state. The differential equations can be also solved as such, resulting in the dependence of the coordinates on the time and phase trajectories in two-dimensional projections. The standard 33-layer model of the atmosphere is used. Water vapor (selective and continual components), CO_2, and O_3 are treated as the absorbing gases.

The model well reproduces the features of the temperature altitude behavior at variation of absorption characteristics of individual layers. It is shown that at varying the concentrations of absorbing matters in sufficiently wide range, the stationary state does not change its character, remaining a stable node.

The effect of appearing in the equations of members with another type of nonlinearity due to, in particular, accounting for temperature dependence of the albedo is considered. A presence for the Earth of two stable stationary radiation regimes separated by unstable state was marked [1] for one-layer radiation model with temperature dependence of the albedo. The calculations, conducted with the expression for albedo from [2], show that taking into account the explicit temperature dependence for the albedo may result in violation of stability of the temperature altitude behavior within some atmospheric layers.

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A2-25

THE LIGHT FIELD PARAMETERS IN THE KHANKA LOESS LAKE

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Khanka lake is a water reservoir of loess type with a lot of small-sized suspended mineral matter. The indices of light attenuation in the water reservoir at 400 nm wavelength can reach 100 m^{-1} and more. The depth of white disk visibility is 15–18 cm.

The layer-by-layer calculation of the underwater spectral descending and rising radiation in the lake water was performed based on the measurements of indices of light absorption (k) and attenuation using the equations deduced in Ref. 1. Mean cosine of scattered rays (h), required for the calculations, has been determined by the integral light scattering phase function. The shape of the scattering phase function is obtuse in terms of Man'kovskii [2].

The calculations show that the directed irradiance falls to zero at the depths from 10 to 15 cm. The diffuse irradiance grows from zero on the surface to the half and more of the radiation, incident on the water surface and that at the depths of 10–15 cm, and then falls with the depth by exponential law.

At the depths of 10–15 cm the depth mode is practically established, and the decrease of irradiance becomes independent of irradiation conditions (outside) and is determined only by the ratio k/h. As follows from calculations from Ref. 3, the parameter of the depth mode (D) for the lake is 0.25–0.28 (L = 0,89; h = 0,78). The calculated values for incident light irradiance well agree with immediate measurements by means of the underwater irradiance meter.

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A2-26

SOME RESULTS OF AIRBORNE MEASUREMENTS OF VERTICAL PROFILES OF THE TOTAL SOLAR RADIATION INTENSITY

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Regular flights of the airborne laboratory are carried out at the Laboratory of Optical Weather of Institute of Atmospheric Optics since July 1997 in the area of the Kamen-on-Ob city of Novosibirsk region at the heights up to 7000 m. Measurements of meteorological parameters, aerosol and gas composition of the atmosphere, and radiative characteristics of the atmosphere (ascending Q_{sca} and descending Q_{dir} fluxes of solar radiation) were performed. The radiative fluxes were measured by means of two pyranometers, one of them was mounted at the top of the aircraft fuselage, and the second was mounted in the photo–hatch of the aircraft.

This paper presents some results of processing the vertical profiles of Q_{sca} and Q_{dir} in different seasons. It is shown that the value of the descending flux of solar radiation at the height of 500 m in winter varies in the limits 150–200 W/m^2, and in summer it is in the range 700–800 W/m^2. In spring Q_{dir} varies in more wide range 450–800 W/m^2. The value Q_{dir} at the height of 7000 m varies in the range 800–1100 W/m^2 in spring and summer and in the range 150–200 W/m^2 in winter. The value of the ascending fluxes of solar radiation has not so well pronounced seasonal behavior. Q_{sca} at 500 m varies in the range 45–60 W/m^2 independently on the season, and at the height of 7000 m it is less in summer than in winter. The paper also presents the reconstructed profiles of the optical thickness of the atmosphere compared with theoretical calculations.

A2-27

ON THE QUESTION OF CREATION OF THE 3D IMAGES OF ATMOSPHERIC INHOMOGENEITIES FROM THE DATA OF PHOTOMETRIC OBSERVATIONS OF THE SKY BRIGHTNESS

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The problem of prediction of the motion of atmospheric inhomogeneities is often arises. To solve this problem, the operative data are needed of the spatial coordinates and size of each observed inhomogeneity. These data can be obtained the most simply by means of photometric triangular observations. However, it is difficult in practice, because it needs to take into account the great number of parameters, which are badly formalized. So to date the attempts of solving this problem were undertaken, but there are no solution. The noticeable success in development of the information technologies of the last years allows to hope to the success in solving this difficult problem.

The initial data on the coordinates of a lot of unit volume forming each inhomogeneity at some time interval before the prediction can provide the solution of the problem of spatial–temporal prediction of the motion and transformation of size of atmospheric inhomogeneities. But it is not attainable in practice. A substitution of the data on the location, shape and size of an atmospheric inhomogeneity are the data on its cover, i.e. on the surface surrounding the inhomogeneity.

The methods and instrumentation of optical observations should allow to control the location, shape and size of such covers.

The questions related to the reconstruction of the shape and location of atmospheric inhomogeneities observed by means of the panoramic photometric complex are discussed in this paper.

A2-28

AN APPROACH TO ESTIMATING THE COLUMN WATER VAPOR OF THE ATMOSPHERE

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The necessity of estimating the columnar water vapor of the atmosphere often appears when solving the problems of propagation of the optical radiation in and through the atmosphere, for example, when performing optical observations by means of telescopes, theodolites, etc.

A low–expenditure and convenient method for estimating the columnar water vapor is needed for practical use. The majority of methods developed to date provide redundant data and require big expenditures for their realization.

One of the possible approaches to estimating the water vapor on the sounding path is discussed in this paper. This approach is based on the prediction model of vertical distribution of absolute humidity. The prediction model contains a few key parameters the values of which can be obtained from both statistical data and the data of measurements. The error in estimating the columnar water vapor is determined by the error of measurement and the duration of the spatial–temporal prediction.

A2-29

A NUMERICAL MODEL OF THE DAYLIGHT SKY BRIGHTNESS FIELD FOR THE ATMOSPHERE HOMOGENEOUS IN LAYERS

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As science on the optical properties of the atmosphere was developed, the attempts were repeatedly undertaken to create a mathematical model of the angular distribution of the spectral brightness of the sky. The necessity of such a model is obvious. On the one hand, it is the possibility of taking into account the scattered radiation in the atmosphere as background component at photometric observations of objects through the atmosphere and observations of atmospheric inhomogeneities. On the other hand, the degree of accordance of the calculated values of the spectral brightness of the sky and its distribution over the sky with the really observed values is good evidence of understanding of both the mechanism of scattering of solar radiation and the structure of the atmosphere and its current optical state. The developed numerical model of the spectral brightness field of the daylight sky for the atmosphere homogeneous in layers and the instruments for recording the sky brightness and the spectral transparency of the atmosphere ("Vzor" panoramic photometer and solar–stellar electrophotometer) make it possible to approach to solution of this problem complexly.

A2-30

IDENTIFICATION OF CLOUD PHASE COMPOSITION TEST WITHIN ICE AND WATER ABSORPTION BANDS

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The problem of identification of the water phase state in clouds is urgent for meteorology. There are different techniques for solving this problem, the most effective of which are the methods of laser and radar location. Application of the method of passive optical location where the Sun is used as a source of radiation is reasonable under some conditions.

In this paper we analyze the possibility of the use of spectral measurements of transmitted and reflected radiation in the IR wavelength range for identification of the water phase state in cloud. The absorption bands in water, ice and water vapor spectra were selected for solving this problem. The transmission and reflection coefficients of a spatially limited scattering medium were determined as functions of optical and geometrical parameters of the medium, and the relationships between the coefficients were studied.

The absorption bands in liquid water and ice spectra are significantly widened and displaced relatively to the respective water vapor bands. The ice absorption bands are displaced to the low–frequency side comparatively to the water molecules bands. When decreasing temperature, the considered bands are displaced to the low–frequencr side. It is evidence of the fact that the character of interaction with nearest molecules determines the oscillation spectrum of water molecules. The absorption band intensity increases both in water and ice spectrum.

If use two filters for determining the absorption bands, one displaced to the low frequency side relatively to the maximum of the absorption band, and second displaced to the high frequency side, one can judge on the phase composition of the cloud from the transmission coefficients ratio. In this case it is necessary to take into account the absorption of radiation by water vapor which always surrounds the cloud.

The analysis of the principal parameters affecting the solution of the problem is carried out in this paper, and the boundaries of applicability of the method are determined.

A2-31

SOME OF PECULIARITIES OF THE RADIATIVE TRANSFER IN RERADIATION MEDIA

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Light field in the reradiating (luminescent) media is now well studied. At the same time, the effect of multiple scattering on the reradiation parameters taking into account spatial limits of the medium leads to the change of classic features of the light field formation in disperse media which have the centers of secondary radiation.

Absorption of optical radiation by a finite–size disperse medium is studied in this paper.

It is shown that the of absorbed energy depends not only on the individual properties of the molecules but also on the medium volume, which can be determining. The new peculiarities accompanying the concentration suppression of the luminescence are discussed.

The concentration suppression and excitation by multiply scattered radiation either compensate each other or the concentration suppression is so big that, finally, the luminescence yield decreases as the concentration increases. The specific parameters of these processes are determined, and the boundaries of effect of each mechanism affecting the luminescence yield are determined.

A2-32

APPROXIMATE METHOD FOR GAS TRANSMITTANCE CALCULATION

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The approximate methods of transmittance and radiation calculation are widely used in atmospheric investigations. Lowtran method [1], empirical methods [2] and aggregate technique [3] are well known at present. The new method of transmittance calculation of atmospheric gases with low spectral resolution (20 cm^{-1}) is discussed in this report. The absorption band models and line-by-line calculations are used in this method. The regular Elsasser model; static Goody, Plass, Malkmus models; single-line model with their asymptotes are used as absorption spectral models at strong absorption approximation of non-overlapping lines and weak absorption approximation. These models have one, two and more parameters. The model choice depending on both spectral band and molecule are evaluated. To obtain good accuracy as compared with line-by-line data the method of minimization to model parameters is used. The standard data LBL calculations are made for this purpose. This method is included into a computer program. Ritz method for improving the absorption spectral model is also used.

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A2-33

THE LAW OF CHANGE OF CAPACITY OF A DOZE OF G-RADIATION FROM LOCAL RADIOACTIVE - POLLUTES OF A SITE OF DISTRICT DEPENDING ON HEIGHT OF A POINT OF MEASUREMENT

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The air radiating monitoring of district is connected to the decision of a task of definition of capacity of an exposition doze of g-radiation CED $\mathbf{P_H}$ at height of flight of the flying device (FD) **H** and subsequent reduction her with the help of high-altitude factor $\mathbf{K_H}$ to CED $\mathbf{P_1}$ at H = 1 m from a surface of ground.

In case of measurement CED at complex "spotty" pollution of district (for example, failure on Chernobyl atomic station) used on practice existing "translation" the dependences based on an assumption about uniform distribution of radioactive substances on district, are not given by opportunities adequately to define the size of "stain" and size CED on a surface of ground.

For specification of influence of height of flight FD and size of a local radioactive site of district on $\mathbf{K_H}$ by the author in area Chernobyl atomic station was executed experiment. For approximation of experimental data, using theorem about average to expression of superficial activity radiations "stain", and having limited in Taylor-decomposition exhibisional function of easing of g-radiation in air rather **H** two composed, is received expression $\mathbf{K_H}$ as:

$$K_H = \xi / \langle \{1 + \exp(-\gamma H)[\gamma H(1 + \frac{\gamma H}{2})]\} \cdot \ln \frac{\sqrt{R_0^2 - H^2}}{H} -$$

$$- \exp(-\gamma H)(1 + \gamma H) \cdot [\sqrt{R_0^2 - H^2} - H] + \frac{\gamma^2 R_0^2}{4} \exp(-\gamma H) \rangle,$$

where ξ – graduational factor is defined by results of graduational of measurements); $\mathbf{R_0}$ – radius of given complex "stain" of pollution.

This dependence allows to define, in particular, $\mathbf{R_0}$ at height of flight FD **H** = const with an error up to 10%.

A2-34

ZONATION RADIOACTIVE - POLLUTES DISTRICTS AT THE INITIATED DESTRUCTION ATOMIC POWER STATION

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Let's consider variant maximal hypothetically of possible radioactive pollution of district at the initiated destruction atomic power station (APS).

Statement of a task. Are known: capacity shell (CS) initiating destruction APS **Q**; quantity nuclear reactors (NR) on APS **m**; set of the scripts (models) describing an output and distribution of radioactive substances (RS) from an active zone (AZ) NR in the environmental space **n**; parameter **Pi**, describing a degree of destruction i – NR APS, i = 1, ..., m; capacity i - NR_i APS A_i, i = 1, ..., m; coordinates of explosion NR (X_0, Y_0) and NR (X_i, Y_i), i = 1, ..., m; factor of probability enthusiasm AZ NR in a cloud CS (K) (T_o = 1 – at enthusiasm, T_o = 0 - without enthusiasm).

It is required to construct equal line $\mathbf{L_D}$, on which the capacity of an exposition doze of g-radiation (EDR) is equal given EDR — $\mathbf{D_n}$, and to define the area of a zone $\mathbf{S_n}$ limited $\mathbf{L_D}$.

The decision of a task is reduced to construction of a field common EDR in an any point of territory (X, Y) – D (X, Y), developing from EDR $\mathbf{D_0}$ (X, Y) from explosion CS and total EDR D * (X, Y) from distribution RS from AZ NR_i, i = 1, ..., m on n to the scripts.

Is shown, that P (X, Y) = K D_0 (X, Y) + D * (X, Y), where $D^*(x,y) = Sp(\|D_{ij}(x,y)\| \cdot \|\delta_{ij}(Q,R_i,P_i,A_i)\|)$; $\|D_{ij}(x,y)\|$ – matrix, which elements are EDR in a point (X, Y) from i- NR at realization j of the script of an output RS; $\|\delta_{ij}(Q,R_i,P_i,A_i)\|$ – matrix, which elements are probabilities of destruction i- NR APS on j to the script; (d_{ij} = 1 at realization j of the script, d_{ij} = 0 at no realization); R_i – distance from i- NR up to a point (X, Y).

Then, required $\mathbf{L_D}$ is defined as: L_D = {j (X, Y): D = (X, Y) = D_n}, inside which D (X, Y) > D_n, and

$$S_D = \frac{1}{2}\oint_{L_D}(xdy + ydx).$$

B1-01

RADIATION INTENSITY FLUCTUATIONS ON LONG PATH IN ABSORBING TURBULENT ATMOSPHERE

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In the problems concerning the electromagnetic wave propagation through the turbulent atmosphere both along the direct and location paths a situation rather frequently is realized when the path length achieves to values of order of units and tens kilometers. Behavior of the statistical characteristics of optical radiation on the paths of such a length in the case of transparent turbulent medium is now well enough investigated (see, for example, Refs. 1 and 2). It is characterized by the strong fluctuation regime and, in particular, by the phenomenon of saturation of radiation intensity pulsations.

In this paper the results of studying the statistical characteristics of radiation on the long paths in the dissipative turbulent atmosphere are presented. Such a medium is characterized by pulsations not only in the real but also in the imaginary component of the permittivity and also correlation of these components. To take into account of an effect of changes in the imaginary part of permittivity is especially important for the saturation area, as the radiation fluctuations in this area are very sensitive even to relatively small pulsations of the absorption coefficient. The general approaches to solving the problem of transfer of electromagnetic waves in the dissipative random media are formulated in the paper and also the expressions for the statistical moments of radiation intensity and the probability distribution function for intensity are derived for the area of strong fluctuations. The relative variance of intensity fluctuations was studied in details in the saturation area as a function of the ratio of values of pulsations of the imaginary and real parts of permittivity, their correlation coefficient, and pulsation scales. The calculated probability distribution function for intensity was compared with the functions obtained experimentally. An influence of additional mechanisms of radiation stochasticity on the distribution function in the fading area is discussed. The dependence of the return enhancement of radiation when propagating along the location path through the dissipative random medium as a function of the relative variance of the intensity strong fluctuations was established and analyzed.

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B1-02

TRACKING SENSORS FOR ADAPTIVE OPTICS

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Method of light-wave analysis for adaptive optical systems, which is useful in conditions of the strong fluctuations, is discussed. It is proposed to measure the wave phase on a closed trajectory, lying into aperture where the wave intensity is significant, and to locate boundaries of the probably optical vortices within ones the intensity is approximately equal to zero. Operations and schematics of two novel and useful sensors are described, namely Directed-Shear Interferometer and Scan-Hartmann Sensor.

B1-03

PHASE RECONSTRUCTION OF THE OPTICAL SPECKLE FIELD

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Problem to reconstruct the phase of optical speckle field from the measurements of the wave front slopes under the conditions of the strong atmospheric turbulence gets complicated by presence of the screw phase dislocations accompanying the field intensity nulls. The dislocations reduce essentially an efficiency of the light energy transportation and are hidden for the wave front sensors of conventional adaptive optics systems.

The rigor theory for reconstruction of the singular (dislocation) phase using the concepts of the divergence and rotor of the phase gradient which reflect the potential and vortex properties of the phase gradient vector field is presented in the paper. It was established that the divergence contains the same singularities as gradient, therefore the phase can be reconstructed with the use of

the regularized divergence only. The divergence singular is changed by the generalized function that does possible to calculate the phase gradient by the Pompeiu formula. The total phase distribution is reconstruct from the obtained gradient free of noise and singularities of the measured wave front slopes. The potential and vortex properties of the phase gradient vector field have been study.

B1-04

METEREOLOGICAL ASPECTS OF THE SITE TESTING OF MOUNT MAIDANAK

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The statistics of the basic meteorological parameters recorded on a mountain Maidanak (Uzbekistan) over the period from August 1996 till January 2000 is presented. On the available long-term data of the weather station "Mingchukur" a number of clear nights on the mountain Maidanak was shown to be surpassed much more this number in the other points of the Eurasian continent and came to 152. The average wind velocity over all observation period made 2.5 m/s, the predominant wind direction was the south. The results of study of influence of meteorological parameters on the quality of the atmospheric image showed that the low values of the wind velocity and night temperature difference on this mountain, in the main, promoted formation of high quality of the image.

B1-05

AUTOMATIC DEVICE FOR MEASUREMENT OF FLUCTUATIONS OF ABSOLUTE HUMIDITY

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For experimental researches of turbulent flows of a moisture the automatic device for measurement of fluctuations of absolute humidity is developed. It used the spectroscopic method of measurement. The device has V-type trace of the common lengths = 1200 mm. It has two LED transmitter and one photodiode receiver. The transmitters work in a batch pulse mode on lengths of waves 830 and 945 nm accordingly. The frequency of sounding of parameters is equal 5 Hz.

The device has also in the structure the standard sorption sensor of relative humidity from meteorological sphere.

This device as all our devices work in LAN. The LAN is made of two strong wires.

B1-06

OPPORTUNITIES AND LIMITATIONS OF MULTIREFERENCE ADAPTIVE OPTICS

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Laser-guide-star adaptive optics can improve the resolution of imaging systems such as ground-based astronomical telescope or non-astronomical system viewing at short distances through an irregular medium. The field-of-view that is corrected by either a laser or a natural guide star is limited by isoplanatic angle. The most intensively discussed solution of anisoplanatic problem is a concept of multiconjugate adaptive optics, although the direct implication of this concept might lead to an inevitable complication of system design.

We propose a new method to overcome the anisoplanatism limitation. We suggest to use several guide stars to provide estimates of wavefront coefficients for different propagation direction and apply correction to the phase using these estimations. We show that it is possible to obtain enlarged field of view with conventional adaptive optics with a single corrector using modification of correction algorithm. The size of isoplanatic patch depends on distance between the references and always larger than this distance. We show that there is no need to create many references in order to achieve the desirable purpose – to perform the partial correction, which would allow to understand the object s details.

Probable scheme of wavefront reconstruction in a multireference adaptive optics is also discussed.

B1-07

LASER REFERENCE CROOS AS A TOOL FOR TILT PROBLEM RESOLVING

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Adaptive correction for the ground-based telescope is directing to improve of its performance. Development of technical part of project asssumed to include the scheme of creation laser guide star. But it is difficult to correct general tilt of wavefront using

signal from a laser star because the required information could not be obtained directly from measurements of star dither. Some methods to solve this problem can be found in scientific publications, as example: simultaneous measurements of general angular dither of bright natural star and laser guide star, employment of two-color laser guide stars, usage of bistatical schemes for laser guide star formations (with two auxiliary telescopes, and two additional laser sources- illuminators). In two last cases a laser guide star could not be considered as a point source. But all of them increase complexity of the system technical realization. In the present report I shall show new approach for creation of Laser Guide Star as a two croosing lines with two scanning focused laser beams. LGS image show as a croos. Using the differential scheme for measurement may to obtain signal which is proportional of jitter of point source. In the result this signal work effectively for correction general inclination for natural star. Also we offer approach for partially decreasing of focal nonisoplanarity.

B1-08

CORRECTION OF MODES IN WAVE FRONT, CAN BE PROCESSED BY ADAPTIVE OPTICAL SYSTEM

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When we say about compensation of wave front (WF) distortions by adaptive optics system, we mean always that the real WF distortions are the direct sum $\varphi + \Delta\Phi$, where φ determines an influence of the adaptive element (AE) upon WF and $\Delta\Phi$ is the residual distortions, which do not change by AE.

Usually φ is an element of the finite-dimensional space X. The actuator responses are the basis of X and $\Delta\Phi$ belongs to the orthogonal addition to X. It is enough to restore only the component φ with the use of WF sensors for the purpose to compensate φ. The basis X can be orthogonalized and ranked in the basis $\{\varphi_k\}$ and then the WF reconstruction problem is reduced to determination of the Fourier coefficients C_k, components of φ_k, and their compensation in the order of ranking.

In the present paper the coefficients C_k are proposed to be determined from the change of the second order moment of the image in a general enough case of unknown incoherent source.

The second order moments exist for the smooth pupil function and their change ΔM exists also for the discontinuous pupil function as a limit of ΔM for the smooth pupil function. Hence, the regularization of the initial image into the image that corresponds in the first approximation to the image created by an optical system with the smooth pupil function is proposed.

New representation is obtained for the derivatives of the image with respect to the defocusing coordinate allowing judging on properties of the image and its moments.

B1-09

FIRST-ORDER ADAPTIVE SYSTEM FOR CORRECTION OF IMAGES IN SOLAR GROUND-BASED TELESCOPES

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The first-order image correction adaptive system have been tested on Big Solar Vacuum Telescope (BSVT) in Baikal Observatory of Institute of Solar-Terrestyal Physics of RAS. Due to atmospheric turbulence the resolution of ground-based solar telescopes are limited to 1 arcsec.

Application of adaptive correction is a ground-based telescope to improve image quality is possible to improve whole performance of telescope to obtain improvemnet of resolution for spectral measurements of the Sun. Adaptive Optics represent a visible tool for increasing the resolution of ground-based telescopes to the level that will be needed to understand the physical processes occuring on the Sun. In the Laboratory of Coherent and Adaptive Optics of the Institute of Atmospheric Optics RAS (Tomsk) has been conducting research programs in solar astronomy for two years. For creation of adaptive optical system need to develop next stages:

1. estimation of some parameters of turbulence in site of solar telescope,
2. development of technical project under scheme of correlation.

The performance and peculiarities of this system are described.

B1-10

ADAPTIVE CONTROL WITH RAY FLOWS OF MULTIBEAM LASER

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Some of the wide-aperture lasers with an active medium of ring cross-section generate a radiation in the form of several phasing-in beam flows corresponding to the single (multipass) mode.[1] With the help of the tube emergent beam formed by all beam flows of the mode the wave of "clearing" can be created on the sounding path for the sensing radiation inside a trace of "clearing".[2,3] However, the lasers of such a type are characterized by the tilts, varying in time, of wave-fronts of the separate flows caused by the random and non-stationary inhomogeneous of an active medium in the resonator for. In this case to stabilize the spatial characteristics of radiation the application of adaptive system allowing correcting such tilts is necessary.

The results of numerical simulation of the adaptive system for correction of the wave front tilts as applied to the multi-beam laser "Yupiter"[1] are presented in the paper. The segmented mirror was used as the executive element, each segment of the mirror operated with its beam flow.

Model of the system was developed, the quality of which correction was estimated from the focusing functional for the radiation power over the diaphragm arranged after the segmented mirror. The maximum allowed size of the diaphragm ensuring the required quality of adaptation was determined. Two control algorithms were compared. In the first algorithm - "sequential" - each beam is converged to the center of the diaphragm only after the complete convergence of the previous beam. In the second algorithm – "parallel" – all beams are converged simultaneously to the center of the diaphragm (next step for the current beam is carried out after end of an iteration step of the previous one). It is shown that the "sequential" algorithm is characterized by the smaller irregularity of the chosen figure of merit as a function of iteration step. The results of numerical study of the correction adaptive system for 16-beam regime of operations of the laser "Yupiter" are presented.

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B1-11

THE EFFICIENCY ANALYSIS OF WAVEFRONT RECONSTRUCTION ALGORITHM BY SMOOTHING SPLINES IN CASE OF NOISES IN CHANNELS OF ADAPTIVE OPTICAL SYSTEMS

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Potentialities of the optical measuring systems caused by the high accuracy characteristics are substantially limited by the conditions of optical wave propagation through the real material media. To compensate the non-stationary distortions the systems are widely used, in which the phase of optical radiation is measured in the different points of an entrance pupil with the subsequent formation of the wave front distribution over the whole pupil.

Existing methods of the wave front reconstruction[1,2] have a number of limitations, which do not allow us to achieve the high accuracy of processing of the non-stationary distortions. Besides these methods were developed without the allowance for the stochastic character of sighals in the adaptive optical systems. The algorithms were synthesized in the determined statement. However, the adaptive optical systems operate under the conditions of noise presence in the control channels. The conventional optimum methods of nonlinear filtration based on the multi-dimensional Stratonovich equation are not possible to be applied. Extremely large volume of calculations does not allow such algorithms to be realized in real time.

In this paper the algorithm of wave front reconstruction based on two-dimensional smoothing cubic normalized B-splines taking into account the stochastic character of signals at the Hartmann sensor exit and having the high accuracy characteristics is presented. Efficiency of operation of this algorithm was analyzed at the presence of various intensity noises in the channels of adaptive optical system. It was shown that the choice of optimum coefficients of the smoothing spline allows the maximum accuracy of wave front reconstruction at the given signal-to-noise ratio to be achieved.

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B1-12

LIGHT DIFFRACTION AT CAPILLARY WAVES

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The acoustic methods based on light diffraction by ultrasound allow the velocity of liquid flow to be determined with enough high accuracy. In Refs. 1 and 2 the ultrasonic wave is considered as the thin phase screen.

By analogy in the present paper the features of diffraction of Gaussian beam by the capillary waves with wavelength comparable to a diameter of a light beam are considered

Let the capillary wave with some frequency Ω is exited on a free surface of liquid and the light beam is directed normally to a surface. In this case an intensity of the reflected beam contains a set of variable component, whose frequencies depend on both Ω and velocity of a liquid flow (more exactly, its surfaces). However, the velocity of capillary wave propagation with the not too large attenuation is some orders lower than the velocity of acoustic wave propagation. In this connection the measurement of rather small velocity of the flow (0.1 micron per second) is possible. Such measurements can be of interest for study the flows caused by the convection and thermocapillary phenomenon.

The velocity of capillary wave propagation can be determined with a relative error not worse than 10^{-3} from the parameters of the reflected beam by analogy with Refs. 1 and 2. Accordingly, the coefficient of liquid surface tension can be determined with the same error. In particular, for water it enables to estimate the presence of surface-active substances in it.

It is shown that this method of measurement of some parameters of liquids is simple enough from the point of view of realization and can be widely used in practice of scientific researches.

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B1-13

A COMPARISON OF THE SEEING MEASUREMENTS AT MT. MAIDANAK FOR PERIOD 1968-2000

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A mountain Maidanak was found at the end of 60 years during the astroclimatical expeditions in high-mountainous regions of the Central Asia. Later Maidanak became the High-mountainous astronomical observatory of the Ulugbek Astronomical Institute AS RUz. The basic parameter of atmospheric quality (FWHM) was measured on Maidanak by the various devices. And the different groups of the authors obtained the long enough series of the data on the atmospheric quality of the night image. However, these observations were carried out by visual methods, in the main, that caused the certain doubts as to their objectivity. Measurements of the image quality with the photoelectric devices executed by the different groups of authors distinguish by the factor 1.5–2. In this paper the results of the comparative analysis of the image quality data obtained on the mountain Maidanak in the different years are presented.

B1-14

TRANSFER OF NONCLASSICAL LIGHT IN LINEAR MEDIUM

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In precision laser sounding the sources with the lowered quantum noise are prospective. In this connection an interest to study the quantum light propagation in the macroscopic medium is urgent. The quantum formalism for such problems of light propagation was advanced in Ref. 1.

In the present paper the quantum light propagation through the three-dimensional linear medium was considered allowing for diffraction on the located Wannier basis. The non-local Lanjeven equations were derived and diffusivity, which determined by a number of atoms at the top level and cross dimensions of the medium, was obtained. The solution for the field amplitude on an output of the medium was found at the given cross distribution of the field on the forward border and dependent from the noise properties of the medium at its certain geometry. Two cases were considered: (i) – the medium was unlimited in a cross direction; (ii) – the finite dimensions of the medium having the form of the cylinder were taken into account.

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B1-15

AMPLITUDE FLUCTUATIONS OF SOUND WAVE PROPAGATING OVER THE GROUND SURFACE IN THE ATMOSPHERE

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Results of processing of the vast experimental material on investigation of the statistical characteristics of amplitude fluctuations of the sound pressure excited by a ground source on the paths of up to 1.5 km length are presented.

An influence of impedance properties of a spreading surface and change in the regular and fluctuation components of the atmospheric meteorological parameters is taken into account at the data interpretation. The cases of presence or absence of the so-called "sound shadow" on the ground path of sound propagation are methodically separated.

It is shown, that in the weak fluctuations area (the short paths of sound propagation) the experimentally observed variance of fluctuations is greater than the corresponding theoretically expected value calculated for the case of sound propagation in the free space - not less, as believed earlier on the basis of the experimental results of Daigle, Piercy, Embleton, etc. The predictable variances of sound pressure fluctuations on the short path can be calculated with allowance for the fluctuations of the phase difference of the direct wave and the wave reflected by the ground surface. In the presence of the "sound shadow" area along the path of sound propagation the variance of fluctuations grows sharply and "is saturated" at the value of 0.3. For the long path of sound propagation the behavior of the variance of fluctuations is in a good agreement with the theoretical dependence obtained before. Under the strong fluctuations of a sound wave the autocorrelation functions and the fluctuation spectra of the amplitude fluctuations of the sound pressure have the similarity scale allowing for the regular components of the wind velocity. At that the data on the wind velocity were obtained from the parallel measurements of the cross-correlation functions of the sound pressure fluctuations for two spatially separated receivers.

B1-16

GENERAL MODE AND TOPOLOGICAL PROPERTIES OF BESSEL BEAMS. VECTOR SOLUTIONS

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The exact vector solutions of Maxwell's equations for nondiffracting Bessel beams is found and studied. It is shown that all solutions are dividing into two large groups: "uniform" group of modes with topological index kappa = +1 and "nonuniform" group of modes with topological index kappa = –1. It is possible to choose both linearly polarized mixed mode basis and circularly polarized vortex-like mode basis in each mode group. These mode properties is universal for free space and locally isotropic inhomogeneous mediums. There is a dependence of beam's characteristic from topological index in inhomogeneous mediums – so-called topological birefringence.

B1-17

CORRELATION OF CLOUDINESS RADIATION FLUCTUATIONS IN THE RANGE OF 3-5 AND 8-13 MCM

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It is considered that the spatial structure of cloudiness radiation in the range of 3–5 microns is determined by the clouds own radiation, in the main. However, when studying the correlation between the fluctuations in brightness of cumulus clouds (Cu) and stratocumulus clouds (Sc) in the ranges of 3–5 and 8–13 microns it was revealed that the cross-correlation coefficient decreased considerably at reduction of a corner between the directions to the Sun and to the "center" of an investigated cloudiness field. This fact is explained by the contribution from the scattered solar radiation [1].

New data on connections between the fluctuations in these ranges confirming an influence of solar radiation also on the other cloud structures of the cloud brightness fields in the range of 3–5 microns are presented in the paper. The cross-correlation coefficient for the various directions and meteorological situations changes from 0.35 up to 0.96.

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B1-18

STABILIZATION OF SOLAR DISK IMAGE FRAGMENT ON SPECTROGRAPH ENTRANCE SLIT

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Studies in solar physics by methods of high-resolution spectroscopy using narrow-band filters require long exposures (from minutes to hours) and the high spatial resolution of solar telescopes (to 0.05 arcsec). The resolution of ground-based solar telescopes is limited to 1 arcsec on the average.

Image jitter of studied area of the Sun that are caused by atmospheric turbulence and vibrations of the telescope constructions significantly affects the resolution of telescope. We have built and successfully tested a tracking system that stabilized solar disk image fragment on spectrograph entrance slit at the Big Solar Vacuum Telescope (BSVT) of the Baikal Astrophysical Observatory. The tracking system used a sunspot as tracer. Image displacement sensor consists of quadrant photodiod and electronic device generating signals of image displacement. The bimorph deflector is as a steering element.

Depending on atmospheric conditions the relative error changed from 0.15 to 0.25. At strong image jitter a degree of suppression of harmonics that present in image jitter spectrum has appeared above 0.9 in a range of frequencies from 0 up to 30 Hz.

The stabilization efficiency was simultaneously checked with a video camera with the following grabbing of the digitized frames into the computer. As the control was turned, the image centroid variance decreased by 10–16 times and in some case, at high wind, even 25 times.

The tests of the adaptive-optics system for stabilization of solar disk image fragment in the BSVT have shown its efficiency and prospects in operating the telescope.

B1-19

DISTRIBUTED COMPONENT OBJECT AS A MODEL OF ADAPTIVE OPTICAL SYSTEM

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One of the principal tendencies in modern programming is creation of the distributed appendixes, i.e. program modules consisting of several components and connected by a set of interfaces. Every component can be a completely independent program having the own user interface and operating in a separate address space. Generally, the components can be disposed in the different computers. The main advantage of the given approach is the increase of code stability when developing by a group of the authors. The components can be tested separately and such mistakes, as unsuccessful control of the operative memory does not influence on operation of the module practically.

Using Distributed Component Object Model in a language C ++ we created a model of the adaptive system. The model consisted of the following components: the model of beam propagation that was completely independent program simulating the beam propagation through the nonlinear turbulent atmosphere and the model of a flexible mirror. Reference to the components was carried out from the basic module including several algorithms of the beam control. The realized methods of the reference and transfer of the data allowed the components to be disposed in the different computers.

Using the model we obtained the results on the amplitude-phase control of the beam under the conditions of intensity fluctuations. The results together with the complete description of the model will be presented at the conference.

B1-20

REPRESENTATION OF PHASE OF DISTORTED OPTICAL WAVE IN THE ORTHONORMAL BASES FOR TWO MODELS OF TURBULENCE. SIMULATION

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When an optical beam propagates through the turbulent atmosphere its wavefront distorts randomly at the inhomogeneities of medium. One from the approaches to compensate such distortions is the modal method, which corrects several modes in the expansion of distorted wavefront in orthonormal basis.

A choice of basic functions is determined by the specialty of a problem. Zernike polynomials are used frequently because they have a simple analytical expression and their first modes coincide with the classical aberrations. However, if the power spectrum of the distortions is known, its egienfunctions named Karhunen–Loeve– (KLO) functions are a natural choice for a basis to represent random wave phase.

Authors have derived the KLO functions represented through Zernike polynomials [1] and then developed the effective method to represent a phase in different orthonormal bases [2]. The method allows one to calculate the phase expansion coefficients with a high rate using fast transforms and then to obtain the expansion coefficients in KLO basis with the transformation matrices. Variances of phase expansion error and Strehl ratio for different bases have been calculated in numerical experiment [3].

This study has been carried out for the Kolmogorov model of atmospheric turbulence. However, the experimental data do not agree always with this model owing to it is valid within the inertial range of turbulence only. But the range of validity of the Kolmogorov model can be extended introducing in it the outer scale of turbulence.

Authors developed the analytical algorithm to obtain KLO functions allowing for the outer scale of turbulence (the von Karman model). Authors analyzed a representation of random wave phase in different bases, the advantages and imperfections of the method for two models of turbulence in computer simulation.

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B1-21

INFLUENCE OF FLUCTUATIONS OF A VELOCITY OF A WIND FOR A SPATIALLY - TEMPORARY STRUCTURE FUNCTION OF FLUCTUATIONS OF A PHASE OF AN OPTICAL WAVE IN TURBULENT ATMOSPHERE

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In this paper presents the results of the theoretical study of influence of a fluctuation component velocity of a wind for statistical characteristics of fluctuations of a phase of an optical wave propagating through a turbulent atmosphere. An analytical solution is constructed, based on a method of smooth perturbations and the locally "frozen" hypothesis in a random velocity field for the spatially – temporary characteristics of a phase and difference of phases of optical beam with Gaussian distribution in turbulent atmosphere. In this case the inner and outer scales of turbulence are equal to finite values. The asymptotic and numerical analyses of obtained expressions are made. The areas of sen-sitivity spatially - temporary of characteristics of a phase to fluctuations of a velocity of a wind are shown. When the fluctuation component of a velocity of a wind are large, influence of inner scale of an atmospheric turbulence on characteristics of a phase of an optical wave are decreased. The possibility of using of the simple approximating formula for structural function of fluctuations of a phase of a plane or spherical optical wave for the some values of ratio average and fluctuation velocities of a wind is discussed.

B1-22

LASER BEAM PROPAGATION IN A TURBULENT ATMOSPHERE, TAKING INTO ACCOUNT FLUCTUATION OF IMPURITY CONCENTRATIONS

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Propagation of radiation through the turbulent atmosphere with the resonance absorbing impurity is described by the parabolic equation of the quasi-optics. The impurity spatial distribution is inhomogeneous, fluctuations of the impurity concentration influences on the structure function of permittivity fluctuations as well as the fluctuations in density of the pure atmosphere.

An analysis of laser beams propagation was carried out with the aid of the equation for the moments of amplitudes of a field obtained from the parabolic equation with stochastic permittivity function with allowance for an impurity influence.

The impurity propagation in the atmosphere at an initial stage of propagation of a primarily dense impurity cloud arising near to a source of pollution occurs due to the turbulent fluctuation in the air velocity in the atmosphere. The inhomogeneity of the impurity concentration in the atmosphere on the initial stage of it diffusion in the air is comparable to the value of the impurity concentration.

The contribution of the impurity to the structure function of the refractive index fluctuations can be compared with the contribution of the pure turbulent atmosphere. It will takes place for $C_e^2 = 10^{-15}$ cm$^{-2/3}$ and the optical length of absorption equaled 2, if the size of a cloud pollutant $L_{cl} = 70$ m that is quite real size.

The numerical simulation of quasi-optics equation was carried out. The direct and return radiation propagation was considered. To reflect the beam a conventional mirror was used as well as the retromirror. The statistical properties of the value of E_i that is the energy measured by the registration system for the different wavelengths were considered. It is obtained that the root-mean-square deviation $\sigma(E_i)$ can give the average magnitude of the signal attenuation due to the atmospheric turbulence, and a value of this attenuation depends on radiation wavelength. Application of the retromirror does not increase the recorded signal power on the receiver and increases its variance. An influence of the spatial inhomogeneity of the absorbing impurities along the laser beam path was simulated. It was established that this fact leads to an increase of the fluctuations of the receiving signal value caused by fluctuation of the cross distributions of the impurities, mainly; the contribution of the refractive index fluctuations always is less.

B1-23

SPECTRA OF SHIFT OF THE IMAGE OF A SOURCE ON THE CORRELATED AND UNCORRELATED PATHS

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The features of a laser radiation propagating through the spatially – inhomogeneous medium are well known if the wave illuminating the object and the reflected wave pass through the same inhomogeneous of the medium.

It is effect of strengthening of fluctuations of intensity, quadruplicating shift of the image at reflection of a plane wave from a mirror, compensation of shift of the image at reflection from the corner reflector, existence of a narrow peak on background turbulent blooming of a spot in distribution of intensity behind a lens.

The given paper describes the results of experimental study of spectra of fluctuations of shifts of the image for wave passed the layer of a developed convective turbulence and reflected from a flat mirror.

The random shifts of a centroid of the image for two mutually perpendicular directions were measured by dissector system, written and analyzed with the use of a computer.

The measurements were carried out depending on a level of medium turbulence on the correlated and uncorrelated paths. The distinctions in spectra have been shown.

B1-24

FLUCTUATION CHARACTERISTICS OF LASER RADIATION IN SNOWFALL

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In report, results of the analysis of some fluctuation characteristics of laser signal in snowfall in the direct beam are presented. A dependence of a level of fluctuations, autocorrelation functions, temporal frequency spectrum, distribution of fluctuations probability on the optical thickness, on maximum size of snowfall particles, and on the receiver diameters was studied. The measurements have been made at single and multiply scattering. It is shown, that statistical characteristics of fluctuation of laser signal depend on the condition of radiation propagation and on the laser beam parameters. The correlation time of fluctuation signal decreases with the increase the receiver diameters. The intensity fluctuation level of dependence on the velocity of wind.

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B1-25

FLUCTUATION CHARACTERISTIC OF LASER RADIATION SCATTERED FROM A FOCUSED LASER BEAM

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In report, results of the analysis of fluctuation characteristics of scattered radiation from a focused laser beam are presented. It is shown, that feature of high-frequency part spectrum dependence on type of turbid atmosphere (snowfall, rain, fog, smoke) . The correlation time fluctuations of scattered radiation by an order of magnitude smaller, than in the direct of a focused laser beam. Distribution of the probability of fluctuations is unimodal, and has the right-hand sided asymmetry. Distributions are most closely described by the gamma-function. The fluctuation grew to some saturation level depending of maximum size of particles snowfall, with the optical thickness grew. They grew with increasing maximum size of particles.

The work was partially supported by the Russian Foundation for Basic Research, project No. 99-02-16923.

B1-26

THE RELATIVE CONTRIBUTIONS OF VARIOUS LAYERS OF A TURBULENCE OF ATMOSPHERE TO A FLUCTUATION OF ASTRONOMICAL IMAGES

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When use of a model by Gracheva M.E. and Gurvich A.S. [1] described the verti-cal dependence of a structural parameter of an index of refraction of an atmospheric turbulence, the analysis of relative contribution of lower and upper layers of atmos-phere to a fluctuation of astronomical images is conducted. The comparison with ex-perimental data by Roddier C., Vernin J. [2] is conducted. The difference of data of experiment and the results of numerical calculations is marked. On data by Roddier C., Vernin J. [2] lower 3-rd kilometer stratums are given by the contribution approxi-mately equal to the contribution of all remaining upper layers of atmosphere. A model by Gracheva M.E. and Gurvich A.S. [1] results in the greater contribution of the lower 3-rd kilometer layers on a comparison with high layers of atmosphere. The possible reasons of these differences are discussed.

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B1-27

PECULIARITIES OF THE MEAN ANNUAL VARIATION OF THE SCATTERED SOLAR RADIATION AT CLEAR SKY IN THE FORMER USSR

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Solution of a number of problems of solar astrophysical observations depends on the value of the scattered light in the telescope. It consists of two parts – atmospheric and instrumental. The fraction of the atmospheric scattered light is very variable and often imposes a limitation on observation of low–contrast phenomena on the Sun. In this connection, temporal variations of the scattered solar light and their regional peculiarities are of interest for selection of the telescope installation places, planing the observation programs, etc.

The coefficient of the scattered solar radiation at clear sky is determined on the basis of network actinometric data obtained in the former USSR during 10 years. The dependence of the coefficient of the scattered solar radiation on the height of observation is revealed.

B1-28

2D-POLYNOMIAL MODEL OF OPTICAL VORTICES CREATION AND ANNIHILATION

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The optical vortices arise around real-plane zero points, which lie on the zero-crossing lines of real and imaginary parts of wave field. Numerous theoretical and experimental papers are devoted to investigation of such objects; the structure of isolated vortex and his statistical properties are studied there as a rule. The coordinates of real-plane zero points are located in the recovery problems of optical wave fields. However the localization of real-plane zero points is impossible for experimental data this is because of discretization and quantization of signals. Therefore the analytical model is necessary to study of creation and annihilation of the optical vortex pair and other attendant special points during the wave propagation.

The wave field in the area of interest is approximated in generally by irreducible second order polynomial of two variables for conservation of local convexity of zero-crossing lines. The model is compared with results of the Weierstrass preliminary theorem. The possibility and consequences of factorization of this model are analyzed.

It is obtained analytically and numerically, that the local minima precede for zero of wave field intensity, that is complicated point without vortex and which, during field evolution, bifurcate in two real-plane zero points separated by the saddle point.

B1-29

ON THE PROBLEM OF PHASE DISTORTION CORRECTION BY THE NEWTON MODIFIED METHOD IN THE ADAPTIVE OPTICAL SYSTEM

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Problem to compensate the phase distortions Φ using the image $h(x, y, z)$ of the point source can be considered as a problem of a choice of compensating phase effect φ of an adaptive element from the solution of the equation

$$h(x, y, z, \Phi - \varphi) - h(x, y, z, 0) = 0$$

where (x, y) are the coordinates of a point in the plane of image recording z=const. Or from the solution of the system of equations,

$$h(x, y, z_i, \Phi - \varphi) * I_0 - h(x, y, z_i, 0) * I_0 = 0, \quad i = 1.2$$

where "*" is the symbol of convolution, and ... is the intensity distribution over an unknown source.

This problem in such a statement was solving by the authors by the modified Newton method, in which the same matrix of derivatives was used in every iteration. It is a doubtless advantage of the method. However, a question of choice of this matrix, at which the convergence of the method and its stability to data perturbations are provided, is not answered up to the end yet.

We used the various techniques of a choice of this matrix: by the image functional, by the method of selection of an even and off components of Φ, etc. In these researches we used the image spatial spectrum on the low frequencies that allowed us to simplify the tack or to derive an analytical expressions for the matrix of derivatives. But it is not possible always to choose the matrix of derivatives with the necessary properties.

In this paper we present new results of investigation and simulation on the use of the modified Newton method to the considered problem. In these investigations all image spatial spectrum was taken into account when finding the matrix of derivatives.

B1-30

THE MEASUREMENTS OF THE ATMOSPHERIC PARAMETERS AT MT. MAIDANAK FOR OBSERVATIONS WITH HIGH ANGULAR RESOLUTION

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Ground astronomical observations are known to be strictly limited by the atmospheric turbulence. In the framework of the classical theory the size of a long-exposure image in the large telescope can be characterized by the unique turbulence parameter Fried radius r0 named also the coherence radius. It is not still enough to know the parameter r_0, since for observation with the high angular resolution an investigation of temporary, spatial, and spatial-angular properties of wave front are required. In this paper the results of measurements of several atmospheric parameters on a mountain Maidanak (Uzbekistan) over the period from July 16 till July 25 1998 with the use of three devices are presented: differential image misalignment meter (DIMM), universal monitor of image quality (GSM) and 4-channels UBVR-photometer.

Median values of the image quality, outer scale of turbulence, and isoplanatizm angle measured during all period have made 0.64 arcsec, 25.9 m, and 2.48 arcsec, respectively. The average wind velocity was lower of 2 m/s. Correlation between the wave front velocity and wind velocity in the ground layer was not revealed. Turbulence in the ground layer, whose contribution was 10% of the turbulence integral on the average, was not appreciable. The independent estimations of the contribution of the free atmosphere (including the first kilometers from the earth surface) from the measurements of 4-channels photometers gave the small value of 0.3–0.4 arcsec that confirmed a predominance of the turbulence boundary layer. High quality of the image, large isoplanatism angle, and rather low value of the wind velocity promote the observations with the high spatial-angular resolution on Maidanak.

B1-31

PROPAGATION OF LOCATION SIGNAL IN ABSORBING RANDOM MEDIUM WITH LENS PROPERTIES

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The problem is stated and the methods are considered to solve the location tasks for the dissipative random media inhomogeneous on the average. Such tasks arise, for example, in the case of propagation of power laser radiation through the absorbing turbulent atmosphere when an extended thermal lens (refraction channel) is induced by radiation in the area of a beam as a result of thermal self-action or in the case of propagation of location signal in the channel of clearing of cloudy medium. The presence of the refraction channel in the turbulent atmosphere, as is known, can essentially change a process of interaction of a wave with the random inhomogeneities.

In Refs. 1 and 2 the approach to solving the location tasks in the regularly homogeneous absorbing random media based on representation of the complex amplitude of the reflected wave in the integrated form with the Green function of the quasi-optics parabolic equation in the form of the Feynman integral over the trajectories was used. In the present paper a modification of this approach for the case of propagation of the location signal in the refraction channel is proposed. In the approximation of the weak fluctuations the four-dot Green function was derived. The expression for the average intensity of reflected wave (plane and spherical) in the defocusing and focusing channels of the absorbing random medium was obtained with the use of the Green function. The effect of return scattering enhancement for the defocusing medium was analyzed.

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B1-32

ENERGY STREAM–LINES UNDER THE CONDITIONS OF FORMING THE OPTICAL VORTICES

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Spatial dynamics of distortions of the of the laser beam wave-front under the conditions of forming and evolution of the optical vortices have been study, energy stream-lines have been constructed, and regularities of appearing the wave-front dislocations have been revealed.

The system of differential equations for the energy stream-lines (rays) in the three-dimensional space derived based on the parabolic equation for the complex amplitude of the monochromatic wave field was solved by the Euler technique with an automatic step choice. An analysis of the structure of the Umov-Pointing vector field for the different longitudinal coordinates in combination with the solution of the equation system allowed the rays spatial dynamics to be investigated. It was established that the rays were focused in the vicinities of the points corresponding to the knots of the Umov-Pointing vector field for the beam having first the smooth wave-front. Such an energy distribution in the space stimulated appearing the points with zero intensity in the plane transversal to the propagation direction, the pairs of optical vortices were born in these points (bifurcation "nodes – focuses"). Rays trajectories gained the spiral form in the vicinities of arising dislocations. In the process of the beam propagation the vortices first diverged and then drew together and annihilated, the wave-front was transformed from the singular to the smooth one, the rays stopped to twist and then focused as far as the next branch point. The initial point configuration determined the further ray trajectories and vortex evolution.

B1-33

ON THE HIGH ALTITUDE WIND VELOCITY ABOVE THE MOUNT MAIDANAK

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Statistics of wind velocity in the tropopause (200 Mb) above a mountain Maidanak (Uzbekistan) obtained on the basis of the data of three weather stations is presented: "Kokand", "Tashkent," and "Termez" over the period from January 1 till December 31, 1991. The results of the analysis of these data have shown that in the large territory of Uzbekistan the wind velocity at the height of 11–12 kms varies weakly. The average wind velocity on the level of 200 Mb above Maidanak over all period of observation has made of 27 м/s. Comparison of the results with the data obtained in the observatories La Silla and Paranal in Chile have shown a comparatively low value of the wind velocity above Maidanak.

B1-34

DEEP-WATER AUTOMATIC MULTI CHANNEL ACCELEROMETER OF A WATER TRANSPARENCY

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For experimental researches of parameters of a water of lake of Baikal the deep-water automatic multi channel accelerometer of a transparency of a water was developed. The optical way of measurement was realized for determinate of the pollution water. The device provides measurement of a transparency in 6 ranges, and also pressure and temperature of a water. Maximum working depth equal 1500 m.

For the control device used the microcontroller i80196 of Intel Co. This chip has analog and digital inputs and outputs, that allows by a rather simple way to organize algorithms of measurement of parameters of a water and management units of the device.

The communication and power supply of the device is made through water proof two-wire cable.

The device uses economic algorithm of for the control halogen lamp, which is a light source for an optical channel. It considerably increases resource of its activity, that is very important at long duration deep-water observations.

The control the device is conducted from any computer having the series port RS–232. The received and transmitted information goes from the modem built-in in the power source.

B1-35

ANALYSIS OF LASER RADIATION ABSORPTION FOR VARIOUS ATMOSPHERIC PATHS ON THE BASIS OF THE EXPERIMENTAL DATA ON THE SPECTRAL COMPOSITION OF MOST TYPICAL CHEMICAL LASERS

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The development of chemically pumped lasers and their application in atmospheric optics stimulations the progress in study of absorption spectra of atmospheric and pollutant gases, allows to improve the accurancy of laser energy losses along atmospheric paths.[1,2] The dominante components of air that is determined the IR is H_2O. The atmospheric molecular absorption coefficient manifests explicit selective properties, and thus, depend on the spectral compositiom of radiation. Estimates of iodine, HF pulsed radiation absorption under their propagation along inclined and vertical atmospheric paths on the basis othe experimental data on the spectral composition of most typical chemical lasers[2,3] were obtained.

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B2-01

THE INTERACTION OF INTENSE LASER RADIATION WITH A CARBON AEROSOL PARTICLE AT ARBITRARY AIR HUMIDITY

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Physicochemical processes on a surface and around of a carbon particle heated up with high-power laser radiation in the presence of water vapor in the air were considered in Ref. 1. Two regimes of burning there were considered:

1. afterburning of hydrogen evolved in the reaction of carbon with the water vapor, at enough high concentration of oxygen on a surface of the particle, occurs in the thin surface layer surrounding the particle;
2. the concentration of oxygen on the particle surface is so small that the zone of hydrogen burning is separated from the particle surface.

In Ref. 1 the influence of air humidity on the process of burning is studied with solving the system of equations determining the profiles of the reagent partial pressures and temperature around the particle under the condition 1. In Ref. 2 the behavior of the system is considered under the condition 2.

In the present paper the solution of the complete system of the nonlinear differential equations describing the fields of temperature and partial pressures of the reagents participating in 6 chemical reactions is obtained for a general case.

To solve the problem put by the following algorithm was used: we created the system of the nonlinear difference equations,[3] which then was solved by the implicit method of simple iteration.

Comparison of results of the calculations carried out for the cases satisfying to the conditions above described with ones obtained earlier in Refs. 1 and 2 has shown the qualitative agreement between them. The found out quantitative distinctions can be connected with application of the different methods of numerical integration, and also with assumptions accepted in Ref. 1 and 2 at simplification of initial system of the equations.

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B2-02

ACCOUNT OF AN OPTICAL BEAM SPREADING CAUSED BY TURBULENCE FOR THE PROBLEM OF PARTIALLY COHERENT PROPAGATION THROUGH INHOMOGENEOUS ABSORBING MEDIA

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The propagation problem for partially coherent wave field in inhomogeneous media is considered in this work. The influence of refraction, inhomogeneity of gain (absorbing) medium properties and refraction parameter fluctuations on target characteristics of radiation are taken into consideration. Such problems arise in the study of a Stokes wave field gain during the stimulated Raman scattering, target properties of single-pass lasers (x-ray, free electron lasers etc.), inside structure of strongly absorbing inhomogeneous media, acoustic propagation in strong absorption conditions or optical propagation in clearing channels.

On the basis of the solution of the equation for coherence function of the second order the ray-tracing technique makes algorithm of the account of turbulence and gain inhomogeneity for any initial coherence. The basic attention is given to research of the target characteristics of laser radiation (intensity distribution, phase and coherence length) after passage trough active medium depending on spatial refractive, gain and turbulent distributions. The algorithm in this common statement is realized for the asymmetric structure of a perturbation of dielectric constant. An algorithm approbation is carried out for test tasks.

B2-03

DYNAMIC LIGHT SCATTERING ON STIMULATED PONDEROMOTIVE VIBRATIONS OF POLYDISPERS AEROSOL DROPLETS

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The task of the deduction of particle size distribution at present is one of the main problems in laser remote sensing of atmospheric aerosols. There is an opportunity for liquid aerosols of additional information attraction, using a dynamic component of scattered light, that is connected to mechanical vibrations of droplets. These vibrations are caused nether by natural reasons

(a movement of particles in an atmosphere, thermal fluctuations), or can be stimulated by an acoustic or electromagnetic field. A resonant excitation of vibrations and increase of dynamic component amplitude of a scattered signal is possible in the later case. The resonant frequency of a droplet is unequivocally connected to its size, hence, changing the influence radiation modulation frequency it is possible to achieve the vibrations excitation of separated group of droplets with the same size.

The numerical modeling of a scattering by a system of polydispers droplets has shown that the frequency dependence of a scattering signal is sensitive to the changes of initial size distribution shape. However the shape of the frequency dependence is strongly deformed, and directly determination of size distribution is still impossible, that the solving of an inverse problem is necessary. The solving of this problem was carried out by standard FORTRAN mathematical library procedures and has allowed the restoring of particle size distribution with a good accuracy. The research of influence of accidental mistake in a scattering signal on the result of restoration is carried out. For the small particles this mistake become fatal in the final result, for large particles, despite of significant growth of mistake, averaging of restored distribution lets one to achieve satisfactory conformity to initial size distribution.

The researches carried out have shown a real opportunity of practical application of a dynamic light scattering on ponderomotive vibrations for restoration of the particle size distribution of liquid aerosol.

B2-04

EFFICIENCY OF OPTICAL FIELDS INTERACTION AT UNELASTIC LIGHT SCATTERING PROCESSES IN SPHERICAL MICRORESONATORS

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The processes of nonlinear light scattering in the transparent microparticles are connected with the presence of resonances of an internal electromagnetic field in the particles. The question on conformity each other of the spatial structures of incident and scattered optical fields interacting in the particle is in close interrelation with the problem to determine the optimum conditions of excitation of stimulated scattering (SRS, SBS).

Numerical experiments allowed us to simulate the "double" SRS resonance in water drops of the various size for the various combinations of modes excited in the particle. The normalized coefficient of spatial overlapping of fields was introduced

$$\bar{B}_C(\omega_L, \omega_S) = V_a \int_{V_a} B_S(\mathbf{r}) B_L(\mathbf{r}) d\mathbf{r}' / \int_{V_a} B_S(\mathbf{r}) d\mathbf{r}' \int_{V_a} B_L(\mathbf{r}) d\mathbf{r}'$$

where a_0 is the particle radius; $B_L(\mathbf{r})$ and $B_S(\mathbf{r})$ are the functions of inhomogeneity of the particle internal field at the frequencies ω_L and ω_S, respectively.

It was established that the most effective interaction of the fields of incident and scattered waves was achieved at equality of the orders of exit and entrance SRS resonances (the resonance for the Stokes wave and pumping wave, respectively). It was caused mainly by coincidence of spatial structures of the interacting fields in the radial direction. Ii was shown also that the best overlapping of the fields was observed for the resonant modes of the same polarization.

The obtained results are in a good agreement with the known experimental data on study of SRS in the liquid particles in the case of realization of the "double" resonance conditions.[1]

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B2-05

NONLINEAR EFFECTS AT ABSORBTION OF LASER RADIATION BY WATER MEDIA, CONTAINING PHENOLS

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The necessity of creation of high-sensitivity methods for the laser-fluorescent analysis of the ecological ecotoxicants in the water medium and also their photodecomposition requires to study the nonlinear effects arising in such media at laser excitation. Unique properties of the laser sources of excitation allow us to increase considerably a threshold of detection of various impurity, to control exactly decay of the ecotoxicants by the fluorescent methods, and sometimes to influence effectively on the photolysis. Phenols are widespread pollutants of water objects meeting not only in the open reservoirs but also in the underground waters.

The laser photolysis of water solutions of phenol and parachlorophenol at excitation by radiation with the various wavelengths (222, 266, 308 and 337 nm), power, and pulse duration was realized. The opportunity is shown to influence on the photolysis ways with changing the excitation parameters, for example, power density. Change in the power density results to the nonlinear effects in absorption that, in turn, can change ways and velocity of the photoreactions. The comparison of efficiency of photolysis for the phenol and chlorophenol was carried out at excitation to the bottom exited state.

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B2-06

TWO-PHOTON EXCITED LUMINESCENCE IN DYE DROPS

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The directions of molecular optics are intensively developed last time based on the two-photon interaction of the laser radiation with organic molecules. The intensity of two–photon excited luminescence of organic molecules is proportional to the cross–sections of their two-photon absorption, which are of order $10^{-49} - 10^{-51}$ cm^4·sec/phot·mol. Hence, the quite high intensity of the exciting radiation are needed for excitation of the two-photon luminescence. Such values of intensity can be realized in practice if use the organic dye solution in the liquid-drop state. Indeed, ability of a spherical particle to concentrate the incident electromagnetic radiation in its volume and the presence of its own resonance modes lead to the significant local increase of the amplitude inthe near-surface layer of the sphere. The results of investigations of the TPEL dye drops are presented in this paper. The luminescence of 1-mm drops with solution of 6-aminophenalone in ethanol and 6-G rodamine in dibutilphtalate was excited in the experiment by the focused laser IR radiation (the radiation wavelength was 1064 nm, the pulse duration was 10 nsec and the pulse energy was 10 mJ). The energy and spectral characteristics of the drop irradiance were measured at different spatial position of the exciting laser beam (cross-section of 200 μm) inside the drop. Transition from the characteristics square dependence of the TPEL intensity to the linear one with subsequent saturation and narrowing the TPEL spectral line allows us to suppose that the spontaneous TPEL is transformed to the forced one as some pumping threshold has been reached.

B2-07

HIGH INTENSITY OPTICAL EFFECTS USING MILLIWATT LASERS

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A novel class of optical materials, silver-fractal-aggregate/microcavity composites, have been fabricated and experimental optical investigations on them carried out. Micron-sized fractal aggregates are prepared by adding a suitable organic acid to an aqueous solution of 20–30 nm diameter colloidal silver particles. Aggregates, typically containing several thousand silver particles, have a fractal dimension of approximately 1.78. The microcavity consists of a 1mm outside diameter hollow quartz tube having a wall thickness of 150 micrometers. Composites are prepared by filling the microcavity with a fractal solution using capillary action. Coupling between fractal and microcavitonances in the composite results in extremely large local field enhancements (average enhancement, 10*12–10*15, local enhancement, 10*17–10*21), leading to the observation of many nonlinear optical effects using extremely weak pumping sources and/or extremely low concentrations of spectrally active molecules. In this talk, we describe some recent experiments in which we have observed lasing from nanomolar Rhodamine 6G dye solutions, and 2- and 3-photon hyper-Raman emission from micromolar Sodium Citrate solutions, using cw, mW (or smaller) pump lasers such as a red HeNe at 632 nm, a green HeNe at 543 nm, and an Argon at 514 nm. Possoible applications are discussed.

B2-08

THE RESULTS OF EXPLORATION PROBABLE STRUCTURE OF SEISMOGENEOUS PERTURBATIONS SEISMOACTIVE REGIONS BEFORE STRONG EARTHQUAKES

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Manifestation of the lithospheric abyssal structure is registered on the space photographies of cloudiness. There are among the revealed effects the narrow slow-moving cloud gap above the lithospheric breaks livening up before strong earthquakes, bank of clouds in the almost clear sky, or sharp rectilinear borders of cloudiness coming to the break. The extent of similar effects runs up to hundreds kilometers.

The explanation of beam structure of the atmospheric seismogeneous perturbation above the seismoactive region before strong earthquake is proposed. The beams–folds of the atmospheric perturbations is focused in the epicenter of earthquake.

When analyzing the field of wave perturbations of medium from a pair of the point oscillators the condition can be used of isotropy of the considered medium volume and wave propagation. The use of the oscillator pair in the model is explained by the fact that the systems of symmetric oscillators deprived of their symmetric part complete it energetically up to the symmetric radiance interference pattern by change of intensity of the interference field. Based on that the model of thermodynamic perturbations of a surface of the seismotectonic anomaly as a source of the wave perturbation of atmosphere is proposed. The calculations showed that at occurrence of a frequency difference in radiation of the oscillators an immediate deformation took place for the interference field having a beam character and curls of the interference beams into the closed ellipsoidal formations.

To check the results of simulation of the morphostructures of atmospheric perturbations the seismogeneous structures were diagnosed in general contents of the atmospheric ozone above the Central Asia. The results of the diagnostics confirmed an existence of the seismoozone effects having a complex structure corresponding to the simulation results.

B2-09

GENERATION OF ACOUSTIC PULSES ON THE NATURAL CENTERS OF ABSORPTION WITH DISTRIBUTION CO_2-LASER ON ATMOSPHERIC PATHS

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The task of effective transportation of laser energy through an atmosphere means, including, research of influence meteorological and physical of a condition of an atmosphere on its attenuating properties. For a case of propagation of high power laser beams with length of a wave in a spectral window of a transparency of a gas atmosphere the special meaning has influence of nonlinear optical effects raised on an aerosol component. The establishment of empirical dependence between meteorological conditions of an atmosphere with a transparency of the channel of distribution has the important independent meaning. However impossibility in atmosphere conditions to simulate the whole range of probable situations requires to carry out physical interpretation of the received dependences which are taking into account influence of processes of interaction of laser radiation with substance of an atmosphere. Such interpretation is possible on the basis of adequate definition of sold physical processes in each particular case. The technique, fulfilled in laboratory conditions, of identification of modes of nonlinear interaction under the acoustic response, allows under the chosen indicator characteristics of an acoustic pulse to identify processes sold in atmosphere conditions. In work the results of definition of nonlinear optical effects and modes of their course are submitted with distribution of laser pulses on atmospheric lines with the various power characteristics of radiation and meteorological condition of an atmosphere.

B2-10

THE CHARACTERISTICS OF THE OPTICAL AND ACOUSTIC RESPONSE WITH VARIOUS REGIMES OF NONLINEAR INTERACTION OF LASER RADIATION WITH AN ABSORBING AEROSOL PARTICLE

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The operative definition of a regime of interaction of laser radiation with absorbing substance, with intensity sufficient for initiation of nonlinear-optical effects, is necessary as for tasks of atmospheric optics, for example for the forecast of efficiency of transfer of laser energy through an atmosphere, with its various optical and physical condition, and some of other tasks, in which needs the control of balance of laser energy spent on excitation of various mechanisms of nonlinear interaction with absorbing substance.

Earlier carried out researches have shown an opportunity of identification of regimes of interaction of laser radiation with absorbing aerosols under the peak and temporary characteristics of a generated acoustic pulse. For realization of operative diagnostics of regimes of interaction the complex of the equipment with frequency by a passband up to 1 MHz, allowing in real time is developed to register and to process simultaneously up to four information channels. In work the simultaneous measurement of the optical and acoustic responses was carried out with thermal, evaporative, explosive and breakdown regimes of interaction of pulse radiation CO_2 laser with an aerosol particle. The program support of a complex allows to carry out frequency, correlation, temporary, statistical analysis of the data.

B2-11

THERMOCAPILLARITY MECHANISM OF LASER BEAM SELF-ACTION IN TWO-COMPONENT MEDIUM

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Thermocapillary mechanism of nonlinearity of two-component medium (aerosol, microemulsion) was studied. In the case of this mechanism a drift of particles in the temperature field is caused by dependence of the surface tension coefficient for the border of phase separation on the temperature. Redistribution of the particle concentrations in this case changes the local refractive (absorption) index of the medium providing, thus, an existence of nonzero coefficient of the effective cube nonlinearity. In the framework of the linear nonequilibrium thermodynamics a change in the permittivity of two-component medium at action of incident radiation is caused by two flows, thermal J_T flow and concentration J_C one, which are mixed thermodynamically and determined by the kinetic coefficients Lij in the general case.

In the case of weak absorbing medium the expression for the effective coefficient of the cube nonlinearity $n_2^{eff} = (\partial n\, \partial I)$ was derived. For the one-dimensional case $n_2^{eff} = \alpha D_{21} K^{-2} |D|^{-1} (\partial n / \partial C)$, where n is the complex refractive index of the medium; I is the radiation intensity; C is the concentration of disperse particles, $|D| = (D_{11} D_{22} - D_{21} D_{12})$; D_{ij} are the diffusion coefficients expressed through Lij, K is the wave vector of the dynamic hologram; and α is the absorption coefficients of the medium.

Experimental study of the thermocapillary nonlinearity was carried out in the bubble medium both in the scheme of self-action of laser radiation and in the scheme of record of the dynamic hologram. The formed hologram had an amplitude-phase character; but due to the relatively large size of bubbles the lattice of the extinction coefficient prevailed.

One of effects influencing on the power and dynamic characteristics of the thermocapillary nonlinear medium is the "longitudinal" instability of a microparticle in the non-uniform thermal field. In the experiments with a single bubble its not damped oscillations along one coordinate were revealed at illumination of the cell by the laser beam having the cross-section intensity distribution stretched along the same coordinate.

B2-12

ERROR OF THE RAY-TRACING TECHNIQUE FOR A PROPAGATION PROBLEM OF A PARTIALLY COHERENT RADIATION THROUGH INHOMOGENEOUS MEDIA

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The error of the ray-tracing technique [1] for a propagation problem solution is studied in this work for the case of inhomogeneous absorbing media. This technique is based on the unique assumption that an average phase front surface have the parabolic form on the size of a coherence length. The technique is asymptotically exact since it gives exact solutions at limiting cases when the coherence length tends to zero or when the distribution of complex dielectric constant of medium has the parabolic form. To estimate the technique error in case of coherence length not equal zero and different distributions of dielectric constant the comparison is executed for solutions received by the ray-tracing technique and exact solutions for model tasks. The two-dimensional beam propagation is considered. The dimension of a coherence function decreases from five down to three for this case. Consequently, the method of separation on the physical factors with using the algorithm of fast Fourier transform is possible.

It's obtained that the error of power and statistical characteristics of radiation is no more than 15% for extreme cases. For practical problems the error of the ray-tracing technique is less then 3–5%. Thus, the ray-tracing technique admits the construction of effective numerical algorithms and allows to obtain the solution of a propagation problem with a high accuracy.

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B2-13

PARAMETERS OF SITES OPTICAL BREAKDOWN OF AIR BY RADIATING POWERFUL CO_2 LAZER

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The results of processing the photographies of sites of optical breakdown of air, appearing in the field of the focus of radiation of microsecond duration CO2 lazer with the wavelength 10.6 μm. and density of power in the field of formation plasma sites 10^9 w/cm^2 are presented in this work. Lazer radiation was focused by the spherical mirror with the focal length of 6 metres. The diameter of ray in the focus of mirror formed 2 cm. Spherical plasma sites appear at the distance from 20 cm. to 60 cm. from the focus of the mirror. Diameter of sites reaches 10 cm. The lazer ray size at the specified distance from the focus changes from 3cm. to 5 cm. Plasma site is surrounded by 5 cm of shining halo., the brightness of its shining decreases with removing from the site. On the photographies you can obviously see a transition from the mode of single-line spreading of plasma formation straight a head to the ray of lazer to the mode of volume increasing of plasma. Time of transition to the new mode evolution of plasma corresponds to duration of the front of lazer impulse 200 ns. The absence of radiation of plasma formation in spectral ranges 0.63 0.5 μm., and fluctuation of the power of radiation in the field of 0.4 μm, discovered by means of photomultiplier tube, point to the sole reason of the given phenomena- a high concentration of nitrogen dioxide in the halo of site of plasma 10181/cm^3 at the temperature of about 3000 K.

The mechanisms of observed phenomena based on the experimental results are discussed in this report.

B2-14

OPTO-ACOUSTIC EFFECTS ACCOMPANYING A LASER-INDUCED BREAKDOWN ON THE MONODISPERSE SOLID AEROSOL PARTICLES

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Generation of acoustic radiation by local plasma formations initiated on the solid aerosol particles is one of the nonlinear effects of an interaction between the high-power laser radiation and the atmospheric aerosol. In the present report, the time histories of acoustic pulses generated by discrete plasma formations initiated on an ensemble of solid monodisperse aerosol

particles under the action of laser radiation are presented. A breakdown was initiated in the region of laser beam caustic by focusing the GOS-1001 laser radiation with wavelength 1.06 mm, pulse duration 1 ms, and energy per pulse 1 kJ at a distance of 50 cm. Monodisperse 7-, 14-, and 28-mm aerosol (silicon carbide) particles were injected into the caustic region. A system of signal recording and processing comprised a receiving microphone placed at a distance of 15 cm under the beam caustic and a precision impulse sound level meter. A signal from an amplifying output of the sound level meter was fed into an ADC. The 50-ms realizations were digitized with a digitization frequency of 25 kHz. The measurements have shown that each local plasma formation is a source of a single acoustic pulse, and a total acoustic signal represents their linear superposition. The waveform of a single acoustic pulse for the above-indicated particle dimensions is satisfactorily approximated by a sinusoid.

B2-15

STATISTICAL ANALYSIS OF SPECTRA OF ACOUSTIC SIGNALS IN LASER BREAKDOWN INITIATED ON THE MONODISPERSE SOLID AEROSOL PARTICLES

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The results of statistical analysis of the spectra of acoustic signals generated by local plasma formations initiated on an ensemble of monodisperse 7-, 14-, and 28-mm solid aerosol particles under the action of GOS–1001 laser radiation with wavelength 1.06 mm, laser pulse duration 1 ms, and energy per pulse up to 1 kJ are presented. Time histories of acoustic signals with 50 ms duration were processed. The digitization interval was $4 \cdot 10^{-5}$ s. Time series were processed on a personal computer with the use of the well-known algorithms for estimating the power spectra. Spectra of individual realizations are presented. Because the distribution of particles injected into the region of laser beam caustic was random, this leads to random signal realizations and has allowed us to average the spectra over ensembles of realizations. The signal spectra averaged over 4 realizations for 7-mm silicon carbide particles, 6 realizations for 14-mm particles, and 5 realizations for 28-mm particles are presented. A clearly pronounced wide maximum is typical of these spectra, whose amplitude and halfwidth is determined by the number of pulses from individual plasma formations and their rms amplitude.

B2-16

DECREASE OF THE THRESHOLDS OF NON–LINEAR OPTICAL EFFECTS IN BIG DROPS AT DIFFERENT GEOMETRY OF EXCITATION

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Calculations of the spatial–energy structure of the internal optical field in liquid spherical drops at different geometry of excitation show that the distribution of the intensity of the internal optical field significantly depends on the beam and sphere diameters ratio as well as on the beam position relatively to the center of spherical particle. The peculiarities of the spatial configuration of the optical field inside the sphere also affect the character of manifestation of the non–linear optical effects in spherical particles. When exciting the edge of the spherical particle by laser beam (the beam diameter is less than the sphere diameter), the greater part of the pumping energy is located than at excitation by the beam directed along the sphere diameter, that should lead to the decrease of the thresholds of non–linear effects. Besides, the length of non–linear interaction of the pumping wave with the drop substance molecules increases at such an excitation. The principal conclusions drawn from the calculations of the internal field structure in drops are experimentally confirmed by the results of measuring the thresholds of the forced fluorescence of optical sparkover in dye drops at different geometry of excitation.

C1-01

A HIERARCHY OF MODELS FOR LIDAR MULTIPLE SCATTERING AND ITS APPLICATION FOR SIMULATION AND ANALYSIS OF SPACE-BASED LIDAR RETURNS

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A series of increasingly detailed and general stochastic models for lidar multiple scattering will be derived from a general model. Limits of the different models of this hierarchy of models will be discussed by comparing simulations of multiply scattered returns of ground-based and of space-based lidars and by comparing results of methods for the retrieval of cloud microphysical parameters based on different models. Finally, the problem for the simulation of returns of a space-based lidar which has been agreed upon by the international MUSCLE group to work on for the next MUSCLE workshop in Richmond, USA, will be introduced and first results will be presented.

C1-02

STATISTICAL MODELLING OF STOCHASTIC PROBLEMS OF THE ATMOSPHERE AND OCEAN OPTICS

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The present lecture considers a set of problems of statistical modelling for the transport of solar and laser radiation in stochastic natural media as applied to the problems of passive and active remote sensing of the ocean and aerosol and cloudy atmosphere as well as to the problems of constructing the numerical models of solar radiation fields in clouds and cloudy atmosphere. The basis of this consideration is the statistical approach when the radiation transfer is described by the equation, in which some of the parameters are random functions. A set of new Monte Carlo algorithms and programs has been provided for the purpose. This set includes algorithms for the simulation of homogeneous stationary random fields of continuous and broken cloudiness, the optic parameters of the atmosphere and the ruffled sea surface as well as the simulating the radiation transfer process in stochastic media. A special attention has been paid to solving the problem of optimization of Monte Carlo algorithms. The results of numerical experiments in all aspects of the problems mentioned above are considered.

C1-03

REMOTE SENSING OF HIGH-TEMPERATURE OBJECTS ON THE UNDERLYING SURFACE FROM NOAA SATELLITES: POSSIBILITIES, PROBLEMS, AND RESULTS

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A problem of satellite remote sensing of high-temperature objects on the underlying surface is closely connected with an important environmental problem of monitoring of forest fires. At present it is most rational to use the information of five-channel AVHR radiometer (placed onboard NOAA satellites) for the territory of Russia. In this case, it is important to detect fire sites in early stages. This problem calls for an efficient solution to the problem of automatic recognition of satellite images of high-temperature anomalies whose dimensions are one-two orders of magnitude less than the spatial resolution of the radiometer. To provide the maximum accuracy of solving this problem, satellite data should be corrected for the distorting effect of the atmosphere with real-time consideration of optical-geometrical conditions of observations. An analysis of available information published in the literature indicates that by virtue of the complexity of this problem, the atmospheric correction was not used in the majority of satellite data processing algorithms used for detecting fire sites. Work in this direction is under way at the Institute of Atmospheric Optics of the SB RAS in the last few years. In the given report we present:

- brief analysis of practical experience accumulated in our country and abroad on the detection of high-temperature objects from satellites,
- quantitative estimates of the distorting effect of the atmosphere on the accuracy of solving this problem,
- detailed data of monitoring of fire sites in the territory of the Tomsk Region from NOAA satellites in 1998 and 1999,
- discussion of practical measures to improve the accuracy of remote sensing of small-sized high-temperature objects from NOAA satellites.

C1-04

USE OF LONG-TERM PREDICTION IN AUTOMATIC VERTICAL-INCIDENCE IONOGRAM PROCESSING

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The ionospheric-channel diagnostics includes, as an essential element, the analysis of vertical sensing (VS) ionograms. Modern ionosondes provide ionograms whose processing consists of (1) finding characteristic data points corresponding to the real signal modes, and (2) a subsequent their approximation by means of tracks. Typically, the ionograms have large volumes, and are acquired without a priori information on character of image formation, in the presence of noise, and in absence of additional information. Processing of VS ionograms involves (1) some preliminary steps such as image reconstruction and preparation; (2) data archiving to reduce substantially the data volume and identify times of signal arrival; and (3) arranging of selected points into tracks and attribution of these points to specific propagation modes. The first task is solved using statistical methods of image processing [1]. To treat the second task, the cellular automaton is proposed representing the simplest example of the neural network with local cellular interaction. The third task is handled using the Hopfield's method of artificial neural networks [2]. Because of complexity of the VS ionograms and the presence of scattered signals, errors may arise both in determining signal arrival times and, especially, in arranging data points in tracks. This can be alleviated using prognostic values of the critical frequencies (foE, foF2) and heights h'F of regular layers, obtained from the operational version of ionospheric model [3]. Analysis of results of Institute of Solar and Earth Physics (ISEP, Irkutsk) LFM-sonde measurements has shown that this approach gives good results.

1. Grozov V.P. Processing of ionograms – statistical approach // Proceedings of International Symposium on Radio Propagation (ISRP'97), 1997, Qingdao, China, p. 225–228.

2. Grozov V.P., Nosov V.E., Ososkov G.A., Zaznobina E.G. Artificial neural networks for computer-aided ionogram analysis // Computer Aided Processing of Ionograms and Ionosonde Records / Edit. by Wilkinson P.J., Boulder, USA, 1998, p. 30–34.

3. Altyntseva V.I., Ivel'skaya M.K., Kotovich G.V. et al. Operational version of ionospheric model. Preprint No. 11–91. SibIZMIR, Irkutsk, 1991, 41 p.

C1-05

ADAPTIVE DECONVOLUTION OF BLURRED IMAGES BASED ON AN ANALYSIS OF THE TEXTURE CHARACTERISTICS OF VIDEODATA

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An approach to the deconvolution of images of the underlying Earth's surface recorded from satellites under conditions of the distorting effect of the atmosphere is considered. A salient feature of this approach is that the point spread function (PSF) of a linear reconstruction model is unknown and should also be estimated. To this end, the same image and information that the observable scene comprises texture-homogeneous fragments with "smeared" characteristics are used. To estimate the spectral power characteristics of the image and noise that enter into an expression for homomorphic filtering that provides a basis of this approach, it is natural to take advantage of the videodata obtained during preceding observations with "fair" conditions of vision. The obtained spectral representation of the reconstructing operator of the homomorphic filter is used subsequently for the deconvolution of the observable blurred image. Thus, on the basis of *a priori* information on the statistical landscape characteristics, which can be naturally obtained as a result of cluster analysis on the detection of texture-homogeneous videodata fragments, both the transfer operator of the aerosol effect of the atmosphere and the surface image itself can be reconstructed. The accuracy characteristics of this approach can be improved by means of classification of atmospheric situations and PSF parametrization depending on their forms and a specific procedure of image reconstruction. An example is presented to illustrate the PSF identification and reconstruction of blurred images.

C1-06

MODELING OF TRANSFER CHARACTERISTICS OF ATMOSPHERIC-OPTICAL CHANNELS IN ACTIVE IMAGING SYSTEMS

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Algorithms of statistical modeling are described in this work, and quality characteristics of images of objects recorded through scattering media with active imaging systems are examined. The object illumination is investigated as a function of the optical characteristics of the medium and reflecting surface above which a test-object is located. The power and duration of the adjacency effect are evaluated. The dependences of the image contrast against the background illumination produced by the

medium and underlying surface are presented along with the dependences of the surface image contrast against the background illumination produced by the scattering medium on the optical-geometrical conditions of observations. The effects of scattering multiplicity on imaging of the medium, test-object, and surface are estimated using the spatial selection of the background illumination formed by directly transmitted and backscattered radiation.

C1-07

DETECTION OF FOREST FIRES USING MULTIZONAL SATELLITE IMAGES OF EARTH

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In the report, we analyze multizonal images of forested ground covers available from NOAA and Resurs-0 satellites. From analysis of multiyear data records of different fires on the territory of West Siberia, characteristic features in fire images have been revealed. Forest fire can be considered as physical phenomenon accompanied by radio-thermal emission, rupture of vegetation and soil covers, and powerful ejection of fire-specific aerosol, which motivated using all five NOAA AVHRR channels for construction of fire detection algorithm. Mean temperature front of forest fire was fitted with Rayleigh-on-pedestal distribution curve to ascertain the shape of the spectral density of radio-thermal emission of forest fire front, a characteristic required to determine the minimum detectable forest fire size. We processed the multizonal images available from NOAA satellites and have found that the differential vegetation index (DVI) is a most reliable quantifier of ruptures in forested and soil covers. We have determined DVI distribution laws for burning and burnt areas, clouds, and smokes. Upon analysis, DVIs for background conditions, fires, smokes, burnt areas, and clouds are found to follow, with 95% confidence probability, the normal distribution laws. So, the forest fire detection problem simplified to classical mathematical statistics problem of decisions. In this case, the third AVHRR channel is used to identify anomalous brightness temperatures in excess of 320 K; while the fourth and fifth channels are employed to retrieve thermodynamic surface temperature. The present work provides an algorithm of deciding the presence of forest fires and estimating the corresponding type I and II error probabilities from sampling statistics.

C1-08

SINGULAR APPROXIMATION IN IMAGE COMPRESSION

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Computer methods of data processing currently attract increasing worldwide attention and enjoy rapid development rate, hampered somewhat primarily not by their speed of operation, but rather by ensuing data storage and analysis issues. Enormous data streams fill allocated memory resources so rapidly that a subsequent data flow reduction is required. But, most offensive is that much of the memory is wasted to store unnecessary information on the secondary and insignificant characteristics of phenomena being studied. So the task is to extract the significant information from the total one.

In this report, the procedure of singular approximation is suggested for this purpose; for definiteness, it is applied to satellite images of the earth's surface. In essence, the approach involves two consecutive steps. First, the initial rectangular matrix is subjected to a singular decomposition (SVD), i.e., it is factored into a product of three (two orthonormalized and one diagonal) matrices. The elements of the diagonal matrix are singular numbers arranged in descending order. As a rule, most of the singular values in the matrix are much less than its principal elements. Therefore, after discarding the small singular values, it is possible to substantially "truncate" both orthonormalized matrices as well. This constitutes the second step, i.e., approximation of the initial matrix. Importantly, this gives substantial savings of computer memory required for data storage. If necessary, the information can readily be restored by multiplying the shortened matrices.

This method has been examined and tested against existing algorithms and found to perform well.

C1-09

RATING OF OPPORTUNITIES CLASSIFICATION OF SATELLITE MEASUREMENTS MID-ELEVATION TAIGA REGIONS

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Satellite measurements appropriate to mountain territories are subject to strong influence of a relief, which in tasks classification of a vegetative cover is the interfering factor. Especially it has an effect at use of visual methods of interpretation of satellite photos (images). At data processing of satellite electronic sounding of a surface there is an opportunity of easing of

influence of this factor, by means of radiometric correction of satellite measurements. In the present work the methods of radiometric correction realized in the software package ERDAS IMAGINE were used 8.2. In work the results of classification of satellite measurements of the appropriate territory of Republic Altai are considered (examined), which relief is submitted basically mid-elevation by a type. The satellite measurements were submitted by the information received with ИСЗ "RESOURCE-03" and "NOAA". In of "true" the data wood management, and also landscape analysis of territory were used. The technique of processing of satellite measurements included: visualization and geographical binding of the images to априорной of the information; construction of numerical model of a relief by means of system SURFER 6 and export her (it) in system ERDAS IMAGINE 8.2; radiometric correction of the images; classification of the images with use parametrical and non parametrical of methods of recognition with "teacher"; a rating of accuracy of classification with application of interactive methods of overlay overlapping of maps and images.

C1-10

APPLICATION OF DIGITAL FILTRATION TO THE DYNAMIC IMAGES OF AEROSOL PLUMES

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The propagation in the atmosphere of aerosol plumes from local stationary pollution sources can be studied using different remote sensing techniques including passive methods based on the telephotometer measurements of scattered solar radiation.

In a previous study it was found that, to determine the source strength from dynamical images of aerosol plumes, one can use (a) mean brightness and (b) maximum brightness of the profile of plume images, both normalized by background level. However, the aerosol particles, while being transported in the atmosphere, with time change direction of their travel, and are not confined to move in strictly horizontal or vertical direction. Therefore, generally it has been difficult to determine the direction of particle transport in a given point of plume image and to calculate the second characteristic mentioned above.

As was already demonstrated earlier [1], the strength of a local source with known parameters can be estimated using synthesized images of aerosol plumes. When separate frames of observational video record are used to construct synthesized images of aerosol plumes, the image synthesis depends on variations of the vertical speed and direction of particle transport.

In the report, we explore the possibility of applying digital filtering to dynamical images of aerosol plumes, with the purpose of determining the mean direction of particle transport and, subsequently, estimating the source strength from maximum brightness of the profile. The dynamics of variations of the mean direction of particle transport can then be analyzed to give the vertical component of particle transport velocity.

Thus, the prefiltering of dynamical images can provide information on the maximum brightness of the profile of aerosol plume; moreover, it can be used to study how fluctuations of the vertical component of particle transport velocity and direction of particle transport influence the image synthesis.

1. Dmitriev B.N., Sutorikhin I.A. Digital synthesized images of aerosol plumes // Proceedings of the Sixth Working group "Aerosols of Siberia". Tomsk. IAO SB RAS Publishing, 1999. P. 21–22.

C1-11

SEPARATION OF COMPONENTS IN ASYMPTOTIC ESTIMATES OF LIDAR SIGNALS WITH CONSIDERATION OF MULTIPLE SCATTERING IN THE SMALL-ANGLE APPROXIMATION

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In this report the method of describing a lidar signal with consideration of multiple scattering in the small-angle approximation suggested previously is developed based on asymptotic properties of lidar signal at large receiver field-of-view angles. The main advantage of the asymptotic decomposition used here consists in the opportunity to replace the scattering phase function by one parameter - the derivative of its Hankel transform at zero point. The case is considered when the small-angle scattering phase function can be represented as a sum of the diffraction (D) and geometric-optics (G) components. It is shown that the lidar signal does not depend on the G component in the first-order asymptotic approximation. That imposes some restrictions on the field of applicability of the model. The work is aimed at updating the model of a lidar signal, which would provide information on the G component of the scattering phase function in addition to the advantages of the asymptotic approximation. The main principle of this approach is based on the separation of the D and G components entering into the equation for the optical transfer function of a medium and subsequent transition to the corresponding components of the initial lidar equation. In so doing the asymptotic decomposition is applied only for the D component of lidar signal and the G component is calculated by the standard method. This has allowed us to describe the lidar signal behaviour at large receiver field-of-view angles more adequately and hence to solve inverse problems with higher accuracy given that the requirements to the *a priori* information on the scattering phase function remain unchanged.

C1-12

ESTIMATION OF DIFFERENT EXPERIMENTAL CONFIGURATIONS TO SOUND A DEEP INHOMOGENEITY IN A TRANSLUCENT MEDIUM

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The task of detection of local perturbations in optical properties deep in a plane layer of turbid medium is considered. The inhomogeneity image contrast and limiting visibility range are calculated via diffuse approximation of radiative transfer theory. These characteristics are obtained in an analytical form. Two observation schemes, using (a) reflected and (b) transmitted light, have been discussed. Their merits and disadvantages are demonstrated for the cases when the inhomogeneous region absorbs somewhat stronger than its environment. It is shown, in particular, that a directly illuminated inhomogeneity has a sharper contrast than a diffusely illuminated one when viewed in reflected light, with almost no gain in contrast between the two viewed in transmitted light. The calculation results are compared with data available in the literature and pertaining to inhomogeneity observation scheme with "optimal" distance between the source and receiver. For a local perturbation, the optical depths are determined at which the inhomogeneity is better seen in transmitted than reflected light for all sensing schemes. The influence of inhomogeneity sizes and optical properties on the inhomogeneity visibility characteristics is studied.

C1-13

A LIDAR WITH CHANGEABLE FIELD OF VIEW FOR RECORDING MULTIPLE SCATTERING

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It is known that multiple scattering contribution in a lidar signal greatly depends on microstructure of the sounding medium. A recording of the backscattered signal at various fields of view of the receiving system is an alternate for estimation of the multiple scattering contribution value. Thus, an adjustable spatial filter must be installed in the lidar receiver. At present, a technical implementation of the lidar signal spatial filtering is one of the most challenging directions in the instrumental development of the single wavelength aerosol lidars.

Possibilities of spatial filtering, realized by discrete changes of the field of view of a block of automatic changing of the field stops, are considered. Diaphragms are made in the manner of pinholes in a thin metallic disc, which rotates with a constant velocity. The position sensors check up the insertion times for each of the diaphragms in the on-position and the start times for each new cycle. This ensures a synchronization of the lidar transmitter and signal processing devices.

Peculiarities of the shaping of double scattering signal when probing the dense aerosol formations, inhering on different distances from the lidar, are shown on the basis of theoretical analysis and numerical computations.

C1-14

CONSIDERATION OF A PRIORI INFORMATION FOR THE RECOGNITION OF DOMINANT SPECIES OF TAIGA FORESTS FORM SATELLITE VIDEODATA

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Satellite measurements of forest cover brightness yield variable brightness magnitudes that depend on many factors including conditions of imaging, structure and age of tree species, place of their growth, and optical weather. This significantly complicates the problem of interpreting the forest inventory parameters. Stochastic models of image patterns reconstructed from learning samples are based only on the use of multispectral videodata. At the same time, a large volume of information on the state of natural complexes collected for many years is now available. Its correct application to the construction of statistical decision rules can significantly improve the quality of statistical solutions. In this case, a complicated problem arises to use not only numerical, but also qualitative data to construct the decision rules. We used new nonparametric estimates developed in TSU to reconstruct the unknown probability density functions in combined spaces of diverse parameters to solve the problem of recognition of dominant coniferous species in Ket'-Chulymskii fine-leafed-dark-coniferous forests (Krylov, 1962) from the data of satellite measurements. The *a priori* information was represented by the data on forest types, bonitet, and land category. As a main GIS-instrument, the software package ERDAS IMAGINE 8.2 was used together with program packages developed by us. Our numerical experiments have shown that *a priori* forest taxation information increases the accuracy of identification of the forest state parameters.

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C1-15

ON THE STATISTICAL METHODS OF THE PROCESSING THE SPACE SEA SURFACE IMAGES

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Frequently, the satellite images of sea surface cannot be processed and analyzed adequately without optimal methods of discriminating useful signals against noise interference due to distorting influences of the atmosphere and hydrometeors.

The report discusses different forms of noise sources in multispectral satellite images of sea surface, and provides optimal methods of satellite data filtering based on *a priori* information about statistical criteria characteristic of the real distributions of sea surface temperature field, oceanic fronts, vortices of different origins, and internal waves on continental shelf. Calculations were made for the case of infrared and visible data available from NOAA and SeaWifs satellites.

C1-16

SISTEM OF ORTOGONAL BASE FUNCTIONS FOR SOLUTION OF THE NONSTATIONARE RADIATIVE TRANSFER"S EQUATION

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There are a few methods of solving the nonstationary radiative transfer equation (NRTE). The spherical harmonics technique uses the expansion of scattering phase function into Legendre polynomials, thereby reducing NRTE to a system of equations for expansion coefficients that depend on the spatial coordinates and time. Of great practical value would be a system of orthogonal functions allowing a transition from NRTE to a system of equations for functions that depend on the spatial variables only.

The report considers a general case of nonstationary light scattering, when the time the photon is in the medium is determined by both the average time the photon is at absorbed state, and by the average time of photon travel between two consecutive scattering events. Then, as work [1] demonstrates, the scattering phase function can be expanded in terms of the spherical Bessel functions. In the stationary regime, for an instantaneous scattering event, this expansion modifies to the usual representation of the scattering phase function through Legendre polynomials. The report analyzes group properties of the scattering phase function that admit such an expansion. The nonstationary radiative transfer equation is considered within framework of the theory of representations of the groups of motions in multidimensional Euclidean space. It is shown that the linear radiative-transfer operator is invariant with respect to certain groups of transformations. This invariance property simplifies the task formulated. The desired basis functions belong to the functional space in which irreducible representations of the group of motions in Euclidean space are realized.

1. Gavrilovich A.B. Expansion of light scattering phase function of a disperse medium into spherical Bessel functions. Proceedings of the International conference "Physics of atmospheric aerosol". Moscow, "Dialog-MGU" Publishing, 1999. p. 81–82.

C1-17

DEVELOPMENT OF MATEMATICAL MODEL 0F TRANSFER AND POLARISATION OF SUN RADIATION IN THE ATMOSPHERE - OCEAN SPHERICAL SYSTEM FOR PROBLEMS OF REMOTE MEDIUM DIAGNOSTICS

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Optical observations, from both ground-based and satellite platforms, of the spherical atmosphere of Earth, in tasks dealing with remote diagnostics of the medium and prediction of aerosol climatic consequences due both to the natural and technogenic perturbations, cannot be interpreted correctly without adequate mathematical radiative transfer models. The existing mathematical models of large-scale processes in the atmosphere and ocean are unable to reproduce adequately the real many-parametrical pattern of radiative field. The report describes the radiative transfer model that we are developing currently. Propagation of radiation in the spherical atmosphere-ocean system is treated as a boundary-value radiative transfer problem whose solution is a vector quantity (Stokes vector), having units of intensity, with four components responsible for energetics and polarization state of radiation. The complex structure of aerosol extinction and gaseous absorption is taken into consideration, including such model ingredients as volcanic aerosol layers, anisotropy of surface reflection, characteristics of wind-induced ocean surface roughness, and optical properties of an aquatic medium. To solve this problem, one of modifications of the spherical harmonics technique has been used.

We obtained polar and azimuthal distributions of components of Stokes vector for hemispheres of directions corresponding to upward and downward components of radiation. Calculation of the fields of volume radiative characteristics, temperature of the medium, and heating rates at the different atmospheric levels constitutes an integral part of the overall computation scheme. The used method of calculating the radiative field components is suitable to perform numerical experiments for the purposes of remote optical monitoring of natural and anthropogenic perturbations of the environment.

C1-18

THE INFLUENCE FUNCTIONS AND THE SOLUTIONS OF THE ADJOINT EQUATIONS IN THE THEORY OF THE OPTICAL TRANSFER OPERATOR

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In his works dated to 1964, Marchuk first formulated the theory of conjugate (in Lagrange's sense) equations, significance function, and theory of functional sensitivity in the form suitable to solve direct and inverse problems in satellite meteorology applications [1, 2]. Mikhailov was first to introduce the methods of adjoint solutions to the Monte Carlo theory and algorithms [3]; and, together with Kargin and Kuznetsov, he first used the significance functions to solve one of the problems of remote sensing of underlying surface through the earth's atmosphere [4].

In recent years, the method of adjoint solutions is actively developed and employed to solve many applied problems of global environmental and climate change and global and local climate monitoring [5, 6].

Since the early seventieth, a parallel effort has been to develop the theory of optical transfer operator for solving problems of remote sensing of the atmosphere and surface and correction of satellite data [7, 8].

The present work intercompares two methods based on the influence and significance functions.

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C1-19

THE LINEARLY-SYSTEM APPROACH AND THE THEORY OF THE OPTICAL TRANSFER OPERATOR IN THE CASE OF THE ANISOTROPICALLY REFLECTING UNDERLYING SURFACE

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Three types of problems dealing with multiple-scattering radiative transfer theory and requiring inclusion of (sea/land) surface reflection have been considered. 1) Earth radiative-energy balance problems with the Sun as radiative source; they are predominately solved in the plane-parallel approximation with implicit account of contribution of homogeneous Lambertian or nonorthotropic underlying surface. 2) Problems of remote sensing of the atmosphere and clouds, with the earth's surface as a clutter. 3) Problems of remote sensing of the earth's surface through the atmosphere whose influence must be effectively removed (by applying an atmospheric correction) or adequately accounted for.

To solve the problems of the second and third types, the atmospheric channel is considered as a component of the optical radiative transfer system. Method of the linear transformations in the spatial and space-frequency domains, that involves such concepts as pulsed influence (a substitute for the point source) and pulsed response (a substitute for the image of the point source) [1], is generalized to the systems with narrow and wide monodirectional beams. In particular, such beams are quite natural in tasks dealing with influence functions for anisotropically reflecting (nonopaque) surfaces.

The theory of the optical transfer operator is formulated within mathematical framework of the linear-system approach [2]. This theory, as well as the method of influence functions and spatial-frequency response characteristics [3], are generalized to the tasks dealing with polarization state [4] and two-component transfer systems with internally homogeneous and heterogeneous interface [5,6].

The work is supported by the Russian Fund for Fundamental Research (under grant 99-01-00170).

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C1-20

ATMOSPHERIC OPTICAL PROPERTIES MEASUREMENTS IN INVERSE PROBLEMS FOR THE PROCESSING OF MULTISPECTRAL SATELLITE DATA

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In the report, we present the results of Spectral Atmospheric Transmission Meter (SATM) measurements made as part of the international (Russian - American) experiment "Kursk-91". The purpose of SATM measurements was to reconstruct atmospheric aerosol optical depth and to study its spectral and diurnal variations during subsatellite experiment; and the SATM data can be subsequently used in the models for atmospheric correction of LANDSAT-5, SPOT, and Kosmos-1939 data. The optical depth was retrieved from spectral measurement data using standard actinometric method. The atmospheric transmission was determined by comparing the measured and extra-atmospheric values of direct solar radiation. The device was calibrated immediately under mountainous conditions in the Northern Caucasus prior to and after the experiment. The SATM data on aerosol optical depth well agree with atmospheric measurements by US solar photometer; they show that atmospheric optical properties strongly vary both in space and time, which underscores the importance of ground-based measurements for improving interpretation of satellite observations of variable biophysical parameters of earth surface covers.

C1-21

RECONSTRUCTION OF BINARY IMAGES IN OPTICAL INFORMATION SYSTEMS OF REMOTE MONITORING

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Detailed structural information on weakly emitting objects of different types is very important in many practical applications.

The present report explores the possibility of reconstruction of half-tone images obtained using accumulated binary spatiotemporal signals from weakly emitting object.

A frame recorded in the photon counting mode represents a set of light spots dispersed across the image plane. For every light spot, it is possible to specify its "center of gravity" which characterizes the coordinate of the recorded one-electron event.

In construction of a half-tone image it is assumed that the probability of finding a photon at a given point is proportional to the reflection coefficient (brightness) of the fragment of scene being viewed. In this case, the construction of the half-tone image reduces to construction of an estimate of the two-dimensional probability density. For probability density with arbitrary distribution, nonparametric estimates of Parzen type with some smoothing kernel have generally been used. However, the estimate thus obtained may appear oversmoothed, resulting in blurred half-tone image. To get quite a sharp image, the distribution is estimated assuming that the probability density is inversely proportional to the area of an elementary triangle with vertices coinciding with centers of gravity of distributions of one-electron events. The frame's plane is divided into elementary triangles using Delaunay triangulation. Each elementary triangle is assigned a value inversely proportional to its area. The images thus obtained have then been recast into visually more convenient look.

C1-22

SEPARATION OF COMPONENTS IN ASYMPTOTIC ESTIMATES OF LIDAR SIGNALS WITH CONSIDERATION OF MULTIPLE SCATTERING IN THE SMALL-ANGLE APPROXIMATION

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In this report the method of describing a lidar signal with consideration of multiple scattering in the small-angle approximation suggested previously is developed based on asymptotic properties of lidar signal at large receiver field-of-view angles. The main advantage of the asymptotic decomposition used here consists in the opportunity to replace the scattering phase function by one parameter - the derivative of its Hankel transform at zero point. The case is considered when the small-angle scattering phase function can be represented as a sum of the diffraction (D) and geometric-optics (G) components. It is shown that the lidar signal does not depend on the G component in the first-order asymptotic approximation. That imposes some restrictions on the field of applicability of the model. The work is aimed at updating the model of a lidar signal, which would provide information on the G component of the scattering phase function in addition to the advantages of the asymptotic approximation. The main principle of this approach is based on the separation of the D and G components entering into the equation for the optical transfer function of a medium and subsequent transition to the corresponding components of the initial lidar equation. In so doing the asymptotic decomposition is applied only for the D component of lidar signal and the G component is calculated by the standard method. This has allowed us to describe the lidar signal behaviour at large receiver field-of-view angles more adequately and hence to solve inverse problems with higher accuracy given that the requirements to the *a priori* information on the scattering phase function remain unchanged.

C1-23

EFFECTIVE ALGORITHM TO COMPUTE POLARIZED RADIATION TRANSFER IN THE ATMOSPHERE - OCEAN AND ATMOSPHERE - EARTH SYSTEMS

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A new quick algorithm has been developed for computation of the radiation transfer in the atmosphere – ocean and atmosphere – underlying surface systems in the visible wavelength range taking into account the polarization. The system was assumed to be a stratified medium and illuminated by a wide beam from above. The atmosphere and the ocean were simulated as stratified systems with molecular and aerosol (hydrosol) scattering and absorption. The corresponding models were included into the database. All 16 elements (4×4) of the Green matrix, which transforms the Stokes vector of the incident radiation with arbitrary orientation into the Stokes vector of the multiply scattered radiation at the prescribed depth in the atmosphere or in the ocean were computed.

Our quick code operates in Windows NT and Windows 95. For example, the time needed for computation of the system consisting of the homogeneous layers of the atmosphere and the ocean is about 20 sec at Pentium II – 233MHz.

The quickness of computation has been reached due to the applied approaches. When solving the complicated transfer equation for the matrix 4×4 we used the new general approach taking into account the polarization. The full solution was constructed as a sum of numerical solution by the method of adding the layers and the analytical small–angle solution. The specific technique was used for arising the accuracy of computation taking into account the interaction of the polarized radiation with the rough ocean surface.

The thorough examination of this method performed by means of comparison with the available data of other authors (K.L. Coulson, Z. Secera, H. Gordon) and Monte–Carlo calculations has shown very good agreement. The results of computation can be found at the web–site http://people.physics.tamu.edu/trouble/work.html.

C1-24

COMPARISON OF IMAGE QUALITY OF UNDERWATER OBJECT AND ITS SHADOW IN AIRBORNE PULSE VISION SYSTEM

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Operation of the active pulse systems in the air–water system is simulated on the basis of the recently developed image formation theory, which includes the effects of the object shadow. The object itself or its shadow is observed depending on the selected position and duration of the detector strobe. The contrast and signal–to–noise ratio for both situations are compared. It is shown that detection of the object by its shadow is often more convenient and effective than the generally accepted method for detecting the object image. In particular:

1. the contrast of the shadow image can be significantly greater than the object image, at least, at observation in coastal water areas;

2. the signal–to–noise ratio and the probability of detecting the object by its shadow is often significantly greater than in the regime of detecting the object, especially at observation through the rough sea surface and in coastal water areas.

Besides, there are additional advantages of detecting the under–water object by its shadow:

- the contrast and the signal–to–noise ratio of the shadow image, as well as the probability of detecting do not depend on the object albedo and weakly depend on the strobe duration and the sea state;
- *a priori* selection of the position and the strobe duration are possible, the wide range of the object detection depths is provided.

Performing observations in the shadow regime makes it possible to quickly study the vast sea water areas in the whole range of depths of operation of the optical systems.

C1-25

APROXIMATION OF ENERGY DENSITY SCATTERING RADIATION BY CLOUD

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Energy density profiles of scattered radiatrion have been calculated by the Monte Carlo method for homogenerous cloud C_1. It was considered propogation of flat wave and nonabsorbtion medium. Layers with intermediate values of optical thicknesses from 1.6 to 16 have been explored. We received attitude of density at the input border to density at output of cloud depending from optical thicknesses of layer. Dependency of maximum energy density from the optical thickness layer is presented. Interpritatation of dependencies is presented by account smallangle and diffusion scattering radiation. Simple models of smallangle and diffusion radiation are offered.

C1-26

STUDY OF VERTICAL COMPONENT OF A TURBULENT DIFFUSION COEFFICIENT USING THE IMAGE ANALYSIS OF AEROSOL PLUMES

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The pioneering works in atmospheric diffusion had identified two approaches to theoretical studying of admixture transport in the near-ground atmospheric layer, namely, (a) through solving turbulent diffusion equation with constant coefficients and (b) by determining source-supplied admixture concentrations from statistically derived formulas [1]. Most domestic researchers had pursued the solution of turbulent diffusion equation with variable coefficients. This approach is most universal because it is applicable for different source types, diverse medium parameters, and different boundary conditions. It can also employ turbulent exchange parameters standard in the heat and moisture exchange problems.

Determining the vertical component of turbulence coefficient as a function of main operating factors has been the topic of many research studies. In many models (e.g., of Budyko, Monin and Obukhov, and Berlyand types), the exchange coefficient is found by solving inverse turbulent-diffusion problem using data on admixture distribution or a visual shape of the smoke plume from the source, which depends on this distribution.

The report explores the possibility of using statistical methods of processing and analysis of dynamical images of aerosol plumes to study the atmospheric turbulence characteristics. Aerosol plumes from local sources are considered as tracers, and they can be used to judge the atmospheric turbulence properties.

The future work, hopefully, will include systematic telephotometric observations of industrial plants in Barnaul-city to compile a database and create an atmospheric diffusion model taking specific urban building-up into account.

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C1-27

NUMERICAL ESTIMATES OF INFLUENCE OF SOME MODELS OF THE STOCHASTIC MEDIUM TO THE RADIATION TRANSPORT

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Change of integral characteristics of the radiation field when "Poisson" model [1] of stochastic medium is replaced by spectral model is considered using Monte-Carlo calculations. For this purpose the standard weight estimates with method of dependent tests are used. The obtained algorithms were used for the testing estimation of the probabilities of both penetration and albedo, as well as the mean value of the frequency-contrast characteristics of the scattering coefficients of a random field. The obtained algorithms and some results of numerical calculations are presented.

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C1-28

EVALUATION OF EFFICIENCY OF SATELLITE MONITORING OF FOREST FIRES UNDER DAYTIME AND NIGHTTIME CONDITIONS IN THE PRESENCE OF BROKEN CLOUDS

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The report discusses results of numerical experiment, which is used to compare the efficiency of fire detection from space in the IR spectral interval 3.55-3.93 μm under daytime and nighttime conditions. The main interfering factor is the broken clouds obscuring partially the surface in the radiometer field of view. The detection is made against the background of noise interference caused by thermal emission from surface and by solar radiation reflected by the system "cloudy atmosphere-surface", the latter contribution being significant in the spectral interval under study. The decision rule is constructed based on the Neyman-Pearson test, for which the threshold level depends on the statistical characteristics of background and false alarm probability α.

The report presents the numerical simulation algorithm and discusses the results of calculations of the dependences of signal-to-noise ratio on cloud fraction and surface albedo, made for detection under daytime and nighttime conditions assuming fire temperature is 1000 K and fire sizes are 100 m^2 and 400 m^2. We compare the mean powers of noise interference due to thermal and solar radiation, the mean power of emission from fire, and mean power of total background. Using these results, it is possible to estimate indirectly the efficiency of fire detection as a function of fire size under conditions of the cloudy atmosphere. To calculate, for a given cloud field realization, the power of noise caused by solar radiation, the method of adjoint walks has been used. Histograms of the power recorded by radiometer are presented, together with fire detection probabilities calculated from these histograms. The obtained results indicate that in principle the fires of these sizes can be detected even during day when the false alarm probability $\alpha = 0.1$ and $\alpha = 0.2$. However, at $\alpha = 0$, when the level of noise interference due to solar radiation is high, the detection probability for fire with size 100 m^2 is much less than probability of the fire falling in gaps between clouds.

C1-29

DETECTION OF FIRES FROM SATELLITE IMAGES USING A NONPARAMETRIC ALGORITHM OF PATTERN RECOGNITION IN SPACE OF THE INFORMATIVE PARAMETERS

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A problem of early detection of fires whose sizes are small is extremely important, especially for almost inaccessible and sparsely populated regions. We used videodata recorded with the AVHRR instrument used onboard NOAA satellites to detect fires. A very large number of influencing and background parameters that describe situations do not allow the problem of fire detection to be solved efficiently by an operator. The need arises to use information of all spectral channels, to take advantage of the technique of testing statistical hypotheses and methods of pattern recognition as well as to determine the informative parameters. The average risk functional is a natural criterion for the class of problems on detection and pattern recognition. In this case, a complex of the informative parameters that allow this problem to be solved efficiently is determined from the condition of minimization of this functional. Because the conditional probability density functions being mathematical models of stochastic images are unknown, a problem arises of nonparametric reconstruction of the distributions from learning samples. The unknown

parameters of distributions are determined from the condition of minimization of the risk functional, which is substituted by the empirical risk for the learning samples. To implement the developed algorithm, the data recorded with the AVHRR instrument in summer (May–August 1998–1999) were used. The observations were carried out in the territory of the Tomsk Region, where a large number of fires were recorded. A comparison between the results of execution of the algorithm and the operator work has shown the high efficiency of the algorithm of detecting thermal anomalies.

C1-30

INTEGRATED CORRECTION OF IMAGES RECORDED WITH THE AVHRR INSTRUMENT USED ONBOARD NOAA SATELLITES EMPLOYED FOR RESOURCE-ECOLOGICAL MONITORING

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Considerable recent attention has been focused on videodata recorded with the AVHRR instrument used onboard NOAA satellites and attempts have been made to solve problems of resource-ecological monitoring based on these data. Unfortunately, low resolution and significant geometrical and radiobrightness distortions of these images make their use difficult. We undertake an attempt to perform an integrated correction (normalization) of videodata. The correction includes the normalization of illumination of underlying Earth's surface images recorded in the day time with consideration of the solar zenith angle. The correction for geometrical distortions takes into account variations of the scanning spot projection onto a cylinder of the AVHRR instrument, recalculation of radiobrightness to a fixed diameter, and displacement of the underlying surface due to the daily rotation of the Earth. The following step of image correction is to increase the spatial resolution of NOAA images. In the first stage, the image fragment being corrected is subject to the magnification of a carrier by repetition of image rows and columns. In the second stage, the magnified image is smoothed with the use of local two-dimensional splines. The next step of image correction is the deconvolution of the smoothed image based on the inversion of the convolution equation for an unknown sharp magnified surface image with the point spread function. The modified function with variable variances being functions of image rows and columns suggested by Yakubov V.P. was used as an instrumental function. Examples of integrated correction of model and real images recorded with the AVHRR instrument are given.

C1-31

ESTIMATION OF THE SPATIOTEMPORAL STRUCTURE OF LIDAR RETURN SIGNALS CORRESPONDING TO DIFFERENT MULTIPLICITIES OF RADIATION SCATTERING IN A MEDIUM

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Lidar return signal components corresponding to different multiplicities of radiation scattering in a dispersed medium are analyzed in the report. The contribution of every component to the spatiotemporal signal structure is evaluated in the case of sensing of optically dense dispersed media. Investigations are carried out by the Monte Carlo method for coaxial sensing systems with variable field-of-view angles of receiving systems.

C2-01

ATMOSPHERIC EFFECTS ON IR-SENSOR PERFORMANCE: THEORY AND RECENT EXPERIMENTAL RESULTS

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The development of sensors with better spatial, temporal and thermal resolution pushes the necessity to revise and quantify the different atmospheric effects on sensor performance. Refractive, polarization and turbulence effects are discussed for long range IR imaging systems in a coastal environment. Quantitative results are given based on measurements under different meteorological conditions.

C2-02

LIDAR STUDY OF TEMPERATURE REGIME IN THE STRATOSPHERE OVER TOMSK

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Temperature measurements inferred from signals of Rayleigh light scattering have been regular at Siberian Lidar Station since fall of 1994. Using lidar with receiving mirror 2.2 m in diameter and a transmitter based on Nd:YAG-laser (second harmonic, wavelength 532 nm), the temperature profiles in the upper stratosphere and mesosphere have been obtained [1]. Later on, starting from 1995 the temperature sensing was continued using UV-lidar with receiving mirror 1 m in diameter and transmitter based on the XeCl laser with hydrogen-filled Raman cell (wavelength 353 nm); the use of the shorter wavelength has made it possible to cover the lower stratosphere in the altitude range 13–40 km [2].

From 1995 to present, routinely we have accumulated data series including over 200 nighttime temperature profiles in the stratosphere. The obtained data array has been used in the report to analyze time dynamics of vertical temperature distribution (VTD) at synoptic, seasonal, and annual scales.

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C2-03

EFFECT OF REFRACTIVE TURBULENCE ON TEMPORAL SPECTRUM OF WIND VELOCITY MEASURED WITH A CW DOPPLER LIDAR

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The velocity measured with a CW Doppler lidar is the radial wind velocity averaged over sounded volume. Therefore the temporal spectrum of such velocity can be presented as the product of the spectrum of wind velocity measured at a point and the low-frequency filter function determined in Ref. 1. However, in some cases at large sounded volumes the experimental data diverge the theory developed in Ref. 1. In our opinion the reason of this can be that the refractive turbulence is not taken into account in the theory.

In this work the effect of turbulent fluctuations of atmospheric air refractive index on the temporal spectrum of wind velocity measured with a CW Doppler lidar is studied. The investigation is carried out on the base of the numerical simulation of 1) sounding beam propagation in the turbulent atmosphere and 2) random realizations for the spatial-temporal distribution of the radial wind velocity. The "frozen" turbulence hypothesis is used. The results of the numerical simulation shows that the refractive turbulence can cause the essential random displacements of the sounded volume along the optical axis. The correlation time of such displacements is order of the time of the medium inhomogeneity transfer by the side wind at the distance equal to the initial radius of the sounding beam. From the numerical simulation data we have obtained the temporal velocity spectra at different refractive turbulence levels realized in the atmospheric surface layer. It has shown that the random sounded volume displacements caused by the refractive turbulence can lead to the essential increase of the energy in high-frequency range of the spectrum of wind velocity measured with a CW Doppler lidar. Analogous deviation from the theoretical results obtained in Ref. 1 is observed in the natural experiments.

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C2-04

DIFFERENTIAL LIDAR SYSTEMS: PHASE PECULARITIES OF BEATING SIGNAL

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Differential measurement systems essentially perform comparison of signal amplitudes at two different frequencies, one usually located in an absorption band, and the other taken as reference. The existing literature on such systems pays most attention to amplitude measurements, while disregarding completely the issue of how phase of the mixture of these signals will change given that the amplitude ratio of individual components varies between wide limits. Study of this issue provides, in some cases, a better measurement accuracy using differential methods. Therefore, this work is aimed at studying the phase behavior of beating signal of two oscillations with arbitrary amplitudes.

Study of this issue has revealed main relationships in the phase behavior of beating signal. It is shown that the phase variations of the beating signal follow the sawtooth law. These curves have the sections of direct and inverse behavior. The inverse regime of this sawtooth signal signifies that the envelope of the beating signal reaches its minimum value. The duration of inverse regime is determined by the amplitude ratio of components of the beating signal. The inverse regime has minimum duration when components of the beating signal have equal amplitudes. The larger the amplitude difference between components of the beating signal, the longer the inverse period of sawtooth phase variations. Also, it should be noted that, simultaneously with variations in amplitude ratio of the beating signal components, there also occur changes in the slope of sawtooth phase curve and, consequently, in amplitude value of the phase jump.

These dependences can be used to increase the noise immunity of lidar systems that are based upon differential measurement techniques.

C2-05

PARAMETRIC STATISTICAL ANALYSIS OF DATA WITH AEROSOL MICRO PULSE LIDAR (MPL)

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It is proposed to make space-time spectral analysis of data of an aerosol micro pulse lidar using the parametric statistical approach based on mixed "autoregressive-moving average" model (ARMA). The given approach permits us to obtain spectral estimations of auto- and cross-spectra with high frequency resolution using short time series of data. The determination of ARMA model parameters was made on a scheme of two-channel spectral estimation by Nuttal-Strand method.

The data processing was made in pairs for neighbouring heights, which were 100 m apart. The time range of averaging for spectra does not exceed two hours. The sounding was carried out to height of 10 km and more. Based on auto- and cross- spectra the spectra of normal coherency and phase were calculated.

The coherency spectrum was used for detection regions in the troposphere, where a stable temperature stratification of an air could happened. When temperature air stratification is stable, the attenuation of turbulent exchange between neighbouring layers of the air in the atmosphere. Because of this the statistical interaction of layers is decreased that results in decreasing of values of the coherency spectrum.

Based on phase spectrum, the direction and the velocity of slow vertical movements of aerosol ingomogeneities were estimated in the atmosphere, which happened at the passing of cold and warm air fronts across a point of lidar observation.

C2-06

INTERPRETATION OF THE DATA OF SIMULTANEOUS SODAR MEASUREMENTS OF VERTICAL PROFILES OF CT2 AND CV2 IN THE ATMOSPHERIC BOUNDARY LAYER

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Based on the method suggested by the author, the data of acoustic sounding with the Zvuk-2 three-channel Doppler sodar with operating frequency 1700 Hz capable of measuring the backscattered signal power are interpreted. A closed iterative algorithm considers the excess turbulent attenuation of a sodar pulse when it propagates along the path to the sounded volume. Synchronous vertical profiles of the thermal, $C_T^2(z)$, and velocity, $C_V^2(z)$, structure parameters are obtained for altitudes up to 600 m. It is found that C_V^2 changes 2–5 times as a function altitude, that is, much more weakly in comparison with C_T^2, which changes almost 100 times. In different meteorological conditions, cases of synchronous altitude behavior of C_T^2 and C_V^2 were observed along with cases where the minimum in the C_V^2 profile corresponded to the maximum in the C_T^2 profile. The results of simultaneous

measurements have shown that the main contribution to the refractive index structure parameter $C_n^2(z)$ and hence to the turbulent sound attenuation in the above-indicated altitude range comes from the dynamic turbulence.

C2-07

RESULTS OF SIMULTANEOUS MEASUREMENTS OF WIND VELOCITY FIELD BY ACOUSTIC LOCATOR AND ULTRASONIC ANEMOMETER IN A STEPPE REGION

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In summer 1999, IAO SB RAS had organized an expedition to Orenburg region, which is characterized as a dry steppe terrain. The expedition was aimed, in particular, at performing long-term, 24-h measurements of altitude profiles of the horizontal wind speed and direction, as well as of the vertical wind velocity component, by using sodar "Volna-3" and ultrasonic anemometer-thermometer. In addition, balloon sonde measurements have also been made.

From analysis of the obtained results, we can conclude that, for the steppe region, wind speeds, measured by sodar in the boundary layer and by anemometer in the near-ground layer, generally agree with one another and match well the standard logarithmic wind profile.

Most interesting finding of the expedition is that, in the atmosphere at a perturbed nonstationary state, brought about by thunderstorm front passage, the wind speed and direction strongly vary with altitude and time.

The report also compares the results of sodar and balloon sonde measurements of wind speed and direction.

C2-08

STUDY OF MULTI-DAYS CYCLES OF CHANGES THE COMPONENTS OF TURBULENT DIFFUSION COEFFICIENTS TENSOR IN THE ATMOSPHERIC GROUND-LEVEL

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The work discusses the results of the study of multiday variations of the components of tensor of the turbulent diffusion coefficients in the near-ground atmospheric layer. The measurements were made during summer, fall, and winter of 1999 at the water-coast interface of storage pond of the Ob power plant and the scientific-industrial site of SSC VB "Vector". The time series of instantaneous wind velocity components were collected using a three-coordinate acoustic anemometer; while the turbulent diffusion coefficients were determined by the recursive method of Galkin. In the experiments, we obtained the multiday time series of components of the tensor of turbulent diffusion coefficients. We analyzed the results and revealed that a pronounced diurnal cycle exists in variations of the tensor components. Also, superimposed on the general trend of the tensor component variations are the spikes with amplitudes an order of magnitude larger than preceding and succeeding values. The spectral analysis of the obtained results has also been performed. It confirmed our earlier finding that the off-diagonal tensor elements, usually considered to be negligibly small in the near-ground atmospheric layer, are comparable to the diagonal elements. The work analyzes how components of the tensor of turbulent diffusion coefficient are cross-correlated with components of mean values of wind velocity and temperature, components of the tensor of viscous Reynolds tensions, and with turbulent heat and momentum fluxes.

C2-09

VERTICAL PROFILES OF THE OUTER SCALE OF ATMOSPHERIC TURBULENCE IN THE ATMOSPHERIC BOUNDARY LAYER FROM THE DATA OF ACOUSTIC SOUNDING

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The outer scale of atmospheric turbulence plays an important role in the theory of atmospheric turbulence. It defines the low-frequency boundary of the inertial subrange in the spectra of temperature and wind velocity fluctuations, is a key parameter for estimating and predicting the excess turbulent attenuation of acoustic waves propagating in the atmosphere, and determines the accuracy characteristics of large astronomical telescopes. In this report, the vertical profiles of the outer scale of atmospheric turbulence are presented for altitudes up to about 600 m, derived from the data of acoustic sounding with the Zvuk-2 three-channel Doppler sodar with operating frequency 1850 Hz capable of measuring the backscattered signal power. An iterative algorithm constructed by the author is used for sodar data interpretation. This algorithm considers the excess turbulent attenuation of a sodar pulse when it propagates along the path to the sounded volume. It has been found that the outer scale increases with the altitude for the above-indicated altitude range. Its altitude dependence is approximated by the relation $L_0(z) = L_{00} + A_z^B$. In the surface

atmospheric layer, the outer scale of turbulence L_{00} changes from 2 to 3 m for weak turbulence and from 8.7 to 14.5 m for strong turbulence, which agrees with the data of optical measurements. The power B is in the range 0.5–3.6, depending on the meteorological conditions.

C2-10

LIDAR MEASUREMENTS OF METEOR TRACES PARAMETERS

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Meteor traces have been sensed using laser locator operating in pulsed mode (at 25 Hz) at wavelength 532 nm. A solid-state laser (IZ-51) has been used as a radiative source. The lidar's receiving system included a telescope with mirror 1.2 m in diameter and a photomultiplier tube operating in photon counting mode.

Measurements were made only during clear nights from an astrophysical observatory at 2700 m above sea level 80 km away from Almaty.

We measured the volume backscattering coefficient of meteor traces at altitudes between 30 and 90 km. Parameters of several tens of meteor traces have been recorded and measured, yielding good statistics in terms of such meteor trace characteristics as altitude, measurement time, zenith angle, thickness, density etc.

In measurements of meteor-trace characteristics, we used the method of determining atmospheric inhomogeneities with small thickness and short lifetime [1].

1. Filippov V.A. USSR inventor's certificate No. 1 812 536. 1993. Method of determining shock wave characteristics in the atmosphere.

C2-11

OPTICAL BASIS METHOD FOR ATMOSPHERE HUMIDITY CONTROL, DISTURBING FACTORS STABLE

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The existing optical base methods of determining atmospheric humidity essentially employ measurements of attenuation of radiation propagating along a given measurement base with length determined by the source(-reflector)-detector separation distance. Such measurement schemes have unstable receiving-transmitting components, and these instabilities must be either minimized or mitigated/accounted for during measurements. In the report, we present a base method of atmospheric humidity measurement in which errors arising from variations in parameters of receiving-transmitting components can be effectively removed.

In this method, the optical radiation at wavelengths near center and outside of water vapor absorption line is transmitted through a measurement base in the opposite directions; and two detectors on the opposite sides of the measurement base are used to measure radiative fluxes attenuated along the base (P_1 and P_2) as well as those coming directly from radiative sources (P_3 and P_4). Humidity is determined from signal ratios; so the instrumental constants of detectors, sources, and measurement modules are effectively cancelled out and their variations do not influence the measurement results.

The optical schemes based on this method are exemplified. The method is examined and demonstrated to be reasonably stable over a range of instrumental constants of receiving and transmitting components.

C2-12

CLOUDS VELOCITY MEASURING SYSTEM FOR LIDAR COMPLEXES

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Lidar sensing systems have found many practical applications; and their current versions frequently employ gyroscopic systems for stabilizing lidar optical axis position in space. Using these, it is possible to track the space position of a given object both automatically and manually, and, in addition, to measure its angular velocity. To be capable of measuring the linear velocity of a study object, the lidar system must include, among other things, a range-finding channel and a calculation module. Such an operation mode has been realized in the lidar system based on the 1GP42 device.

The transmitter-receiver's optical axis is controlled through the driving inputs of the gyro-stabilized platform. The orientation of the optical axis is determined from positions of mirrors at the output of the optical component of lidar system. The lidar system consists of a sighting device for pointing the lidar system to the study object, laser range-finder, an additional detector for recording lidar returns, and a lidar control subsystem.

Using this system, cloud velocities of up to 30 m/s were measured with relative measurement error not exceeding 5%.

C2-13

USE OF SODAR "VOLNA-3" FOR MEASURING WIND VELOCITY FIELD MOMENTS AND ESTIMATING THEIR ERRORS

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The report describes the algorithms of determining, from "Volna-3 " sodar measurements, four first moments and associated standard deviations, skewness, and kurtosis for different components of wind velocity field (radial V_r and orthogonal V_{opm} components, horizontal wind speed V_z and direction φ). The quality of estimating these moments is determined considerably by the quality of immediate locator measurements of "instantaneous" radial components $V_r(i)$ and by accuracy of determining centers of their distributions; therefore, to filter out possible outliers, $V_r(i)$ was subjected to an appropriate procedure of iterative data censoring, with subsequent application of adaptive procedure to calculate the means.

To estimate the moments of V_{opm}, V_z and φ, two methods have been used. In the first, their "instantaneous" values are calculated, and for V_{opm} and V_z the further processing proceeds in the same way as for the radial components V_r; in their turn, the φ moments are calculated using the methods of circular statistics. The second method essentially employs the precalculated moments of V_r components and some of their additional statistical characteristics.

To quantify objectively the statistical confidence of obtained information, both point- (standard errors) and interval-like (90% confidence intervals) estimates of random measurement errors have been calculated.

C2-14

APPLICATION OF PARAMETRICAL STATISTICS FOR THE ANALYSIS OF DATA OF METEOROLOGICAL FIELDS IN THE SURFACE LAYER OF THE ATMOSPHERE

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The comparative statistical analysis of experimental data of fluctuations of components of wind velocity and temperature based on nonparametric (Fourier-analysis) and parametric methods of calculation of spectral functions is conducted. The parametrical approach was based on a "autoregressive - moving average" model (ARMA). The determination of parameters of ARMA -model was made under the scheme of two-channel spectral estimation by the Natoll-Strand method.

The data of ultrasonic meteorological stations were subjected to processing. The observations were made in nature at heights from 1 m up to 5 m. Length of realizations was about 17 minutes, and a sampling rate was 4 Hz.

The interest to a parametrical spectral analysis is stipulated by that the use of ARMA -model and other models allows for short temporary sequences to make an evaluation of auto- and cross- spectra with the higher frequency resolution.

In the report the spectra of fluctuations of components of wind velocity and temperature calculated by various methods and for temporary sequences of different length are represented. The cross -spectra were calculated for vertical and longitudinal components of velocity and for vertical velocity and temperature, representing spectral expansions of turbulent fluxes of impulse and heat.

C2-15

PRELIMINARY RESULTS OF VOLNA-3 SODAR MEASUREMENTS OF ALTITUDE PROFILES OF STANDARD DEVIATIONS, SKEWNESS, AND KURTOSIS OF HORIZONTAL WIND SPEED AND DIRECTION

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The report discusses the results of Volna-3 sodar measurements of altitude profiles of standard deviations, skewness, and kurtosis of horizontal wind speed and direction. The measurements were made for the different types of atmospheric temperature stratifications - neutral, unstable, and stable – that were diagnosed from facsimile records of acoustical return signals.

C2-16

MEASUREMENT OF TURBULENT FLUCTUATIONS OF HUMIDITY IN THE SURFACE LAYER OF THE ATMOSPHERE

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The research of turbulent fluxes of moisture above a ground and water surface concerns to number of the most important geophysical problems. The turbulent transfer of water vapor in the lower levels of the atmosphere forms average value and

turbulent pulsings of specific humidity and renders essential influence on a microwave index of refraction and process of propagation of electromagnetic waves.

The automatic optical meter of turbulent micropulsings of absolute humidity is developed and is tested in nature conditions. The meter is constructed on a principle of the infra-red hygrometer, which measures fluctuations of absorption coefficient of radiation in the absorption band of water vapor. The meter, enables on basis of differential technique to receive time series of absolute humidity with frequency up to 4 Hz.

The cycle of experiments in the atmospheric surface layer with use of this meter, twelve ultrasonic single-component sensors of velocity and temperature and two acoustic meteostations which enables one to simultaneously measure the temperature and three components of velocity is conducted. The average values of humidity simultaneously were determined with the help of standard aspiration psychrometer.

The synchronous time series of micropulsings of absolute humidity, temperature and components of a velocity of a wind are obtained. The vertical turbulent fluxes of the water vapor, sensible and latent heat are calculated. The correlations of pulsings of humidity with pulsings of temperature and components of wind velocity are considered. The comparison of spectral distributions of pulsings of humidity, temperature and velocity is conducted. The conclusion is made that for a correct evaluation of stability of the atmospheric surface layer, it is necessary to realize experimental determination of Monin-Obuchov scale, taking into account humidity, and latent fluxes of heat.

C2-17

APPLICATION OF PARAMETRICAL STATISTICS FOR THE ANALYSIS OF FLUCTUATIONS OF AEROSOL SCATTERING COEFFICIENT IN THE SURFACE LAYER OF THE ATMOSPHERE

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Fluctuations of aerosol scattering coefficient are caused by change of a concentration of aerosol particles in the investigated volume due to an atmospheric turbulence. Investigation of random fluctuations of the atmospheric aerosol density was made with an two-angle polar nephelometer of open type.

The processing of original data was made by statistical spectral methods using the classic nonparametric approach (Fourier-analysis) and parametric methods of calculation of spectral functions. The parametric approach was based on a *"autoregressive-moving average"* model *(ARMA)*. The determination of *ARMA*-model parameters was made on the scheme of two-channel spectral estimation by the Natoll-Strand method.

The interest to a parametric spectral analysis is stipulated by that the use of ARMA -model and other models allows for short temporary sequences to calculate auto- and cross- spectra with the higher frequency resolution. The spectra of fluctuations of scattering coefficient calculated by various methods and for temporary sequences of different length are represented. The cross - spectra were calculated for the scattering coefficient and for vertical component of a wind velocity, representing the spectral expansions of the turbulent aerosol flux.

C2-18

EFFICIENCY OF COHERENT RECEPTION WITH APERTURE ARRAY IN TURBULENT ATMOSPHERE

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At present the higher attention is spared to the investigation of the signal-to-noise ratio (SNR) improvement possibility for coherent reception of light with multiaperture systems. It has shown the maximal ratio method is most optimal. This method includes the backscattered radiation reception with some telescopes, the coherent detection, the multiplication of the photocurrents by the amplification coefficients proportional to amplitudes of legitimate signals, and summation of the photocurrent after their co-phasing. In real atmosphere the turbulent inhomogeneities of the air refractive index can be the source of essential worsening of the spatial coherence of the field received wave and, as consequence, the decrease of the heterodyne efficiency and the drop of the signal-to-noise ratio.

In this work the efficiency of coherent reception with aperture array in the turbulent atmosphere is studied. The average signal-to-noise ratios have been calculated by the numerical simulation for the case of the reception with the use of the maximal ratio method. It has shown that for correct calculation of the amplification coefficient of the signal-to-noise ratio (the ratio of SNR at the reception with some telescopes to corresponding value in the case of the single-telescope receiver) for the multiaperture systems used in the turbulent atmosphere it is necessary to take into account the correlation between sounding and backscattered radiations. At short sounding paths the increase of the turbulence strength can lead not to improvement (as it follows from the calculation without taking into account of the correlation) but to worsening of the multiaperture reception efficiency, as compared with the case of the homogeneous atmosphere. When the sounding path is long, the stronger turbulence the more sufficient effect of the increase of number of apertures of the lidar system.

C2-19

ESTIMATE OF STATISTICAL CHARACTERISTICS OF "VOLNA-3" SODAR SIGNAL AMPLITUDES

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Quality of interpretation of the results of acoustic sounding of the atmospheric boundary layer is determined in many respects by an ability of the automated processing algorithms to select a desired signal on the background of a various noise. Study of the signal statistics takes a main place here. Results of analysis of the statistical characteristics for the amplitude envelopes for the narrow-band signals recorded by the "Volna-3" sodar are presented in the paper. The histograms and moments of both purely noise components and mixture of the signal and noise for the various geophysical conditions are considered.

C2-20

THE "VOLNA-3" SODAR. CALIBRATION OF THE RECEIVING-TRANSMITTING PATH

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Acoustic techniques for investigating the atmosphere are based on both frequency and amplitude dependence of the reflected signal on the atmospheric parameters. As the acoustic signal reflected from the atmosphere has very small value, which can not be measured by the standard measuring devices, it is necessary to transform it to the electric signal and to amplify. In this connection, the careful calibration of the receiving–transmitting path is necessary to perform amplitude measurements of the reflected signal. The calibration of the "Volna–3" three-channel sodar developed at the Group of Atmospheric Acoustics of the Institute of Atmospheric Optics is presented in this paper.

C2-21

ULTRASOUND ANEMOMETER-THERMOMETER "METEO-2"

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This paper informs about the new development of the "Meteo–2" ultrasound anemometer–thermometer performed at the Group of Atmospheric Acoustic IAO SB RAS. The device is destined for measuring the instantaneous and mean values of temperature, three orthogonal components of wind velocity, velocity and direction of horizontal wind in the near–ground layer of the atmosphere. Its specific peculiarities are the high technical and operation properties. The last are caused by application of the specially developed small–size ultrasound sensors based on the piezoceramic elements and careful elaboration of the design and electronic circuit of the device.

In particular, the device is capable of autonomic round-the-clock measuring at air temperature from –50 to 50 °C and wind velocity up to 30 m/sec. It is protected from atmospheric precipitation. The sensitivity threshold to turbulent pulsation of temperature and wind velocity is of order 0.01 °C or m/sec, respectively, and the maximum rate of reading these data is 17 Hz. Output data are presented in digital form in the RS232 format. The device can be connected with specialized calculator of meteorological parameters or with the standard computer trough one of its serial port (COM1, COM2, etc.). The special software is used in the last case. The device described has small size and weight (~ 1.2 kg).

C2-22

MINISODAR FOR ATMOSPHERIC INVESTIGATION

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The role of minisodars in investigations of the atmospheric boundary layer is analyzed. The high–frequency small–size acoustic radar (minisodar) is described. The new mS–1 minisodar is destined for monitoring of the structure and dynamic the lower layer of the atmosphere as well as for carrying out different atmospheric investigations of the sound scattering effects, sounding of hydrometeors, etc. It is the portable three–channel Doppler sodar. Each of the channels operates in the monostatic pulse sequent mode and provides transmitting, receiving and processing of the instantaneous primary data in real time, as well as in bistatic pulse and continuous modes. The values of wind velocity and other parameters of the atmosphere are determined after finishing the measurement cycle. The height of sounding in the monostatic mode is from 8 to 200 m, the resolution is 8 m. The operation including transmitting, receiving, processing and imaging of the results is controlled by personal computer. The structural diagram, specifications of the sodar are described. The results of experimental atmospheric investigations are presented.

C2-23

MEASUREMENT OF THE STRUCTURAL CHARACTERISTIC OF TEMPERATURE OF THE NEAR-GROUND LAYER OF THE ATMOSPHERE BY MEANS OF THE "VOLNA-3" SODAR

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The results of measuring the structural characteristic of the random temperature field C_t^2 of the near–ground layer of the atmosphere by means of the "Volna–3" sodar are discussed in this paper. The error in reconstruction of C_t^2 is analyzed as function of the errors in measuring the signal amplitude and some other parameters.

C2-24

MICROWAVE REMOTE SENSING OF SOIL COVER

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In a general system of regional ecological monitoring remote sensing methods of earth covers makes possible an operative estimation of natural and anthropogenic influence, their spatial and temporary evolution. The combination of remote sensing in optical and microwave bands, joint processing methods of orbital and airplane carriers multichannel information and ground data allows to receive the more full information about a state of earth covers. The development of remote sensing methods requires creation of databases on characteristics of interaction of electromagnetic waves with natural formations.

The dielectric characteristics of wet soils and grounds, because of their importance in problems of microwave remote sensing, were studied by many researchers. However there are some phenomena in their behavior, which are insufficiently investigated and are not taken into account for the purpose of remote sensing. There is no a reasonable analysis of experimental data, which would be convenient for model description of a dielectric constant of wet soils with inclusion of bound water characteristics, and also formed the principles for construction of databases on dielectric parameters of soils. There is poorly investigated a joint influence of bound water both salinity on dielectric and radioemissivity characteristics of soils for temperatures above and below zero.

The aims of the paper are to obtain some principle results on dielectric and radiobrightness characteristics of soils and grounds in microwave, using these knowledge to develop the principles for construction of database on dielectric parameters of soils for purpose of remote sensing, to propose algorithms of joint analysis of remote observation and ground-based data in the problems of moisture and ground water table remote sensing, to perform the complex experiment on the territory of Altai region.

C2-25

THE STUDY OF TEMPERATURE STRATIFICATION USING THE DATA OF RADIOMETRY, SOUND LOCATION AND RADIOSENSING

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Reliable knowledge of temperature profiles in the atmospheric boundary layer is the urgent problem. The degree of accuracy of this knowledge determines the success in hydrodynamic forecast of weather, as well as forecast of the local atmospheric pollution, because temperature at some heights or isobaric surfaces is the input parameter to the model calculations. However, in spite of the great amount of experimental data on the temperature profiles obtained by means of different techniques and in different sites, researchers continue to discuss the limits of confidence to their accuracy and selection of the beast method. This problem is the issue of our paper.

The experiment on simultaneous measuring the temperature stratification by three different techniques was carried out in Dolgoprudny since 24 August till 20 October 1998. The following instruments were applied: the MRZ-3A radiosonde, MTP-5 automated remote measurer of the vertical profile of temperature on the basis of radiometry, and the "Echo-1" vertical sodar. Operating frequency of the sodar was 1666 Hz, its vertical range was 800 m, and the vertical range of the MTP-5 profile measurer was 600 m.

The experiment has shown the satisfactory agreement of the data obtained by means of three techniques on the general character of the temperature stratification of the boundary layer in the middle of night, but weak correlation between estimates of the top of near–groun inversion.

C2-26

EXPERIMENTS WITH THE MOBILE SODAR SETUP

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Seven route experiments were carried out in Moscow and its vicinities in the night (two in December 1996 and five in June 1999) by means of the «Echo-1» car-installed vertical sodar. The mesoscale peculiarities of thermal structure of the 800-m high air layer related to the effect of the city and of the complicated relief were studied. The operation frequency was 1666.6 Hz. The high spatial resolution of the sodar, 12.5 m, made it possible to study the thin effects inaccessible for the traditional measurement tools.

Sounding was performed along two routes passing through the city center to both directions to the nearest Moscow region, meridional and latitudinal. Repeated passages from one end to another were carried out, the sodar operated 15 minutes in average at each point. The type of temperature stratification was qualitatively determined from the sodar record of the return signal and the boundaries of turbulent layers related to the inversion were measured. Second immovable sodar operated simultaneously. The concentration of the following atmospheric pollutants were measured at the same time: sulfur dioxide, nitrogen oxide and dioxide, as well as the gradients of the principal meteorological parameters in the lower 2-m layer.

The effect of relief on the turbulent layer top surface was also studied. For this purpose sounding was carried out alternatively at the edge and at the bottom of the most steep slope of Leninskie mountains with the height change of about 70 m. It has shown that the power of the layer near the bottom is, in average, 40 m higher. It is evidence of the flow of relatively cold stably stratified air to the river valley. The peculiarities of the chemical pollution of the lower atmosphere over Moscow and the features of the microclimate and turbulent regime are also analyzed.

C3-01

LIDAR SYSTEM FOR ATMOSPHERIC POLLUTION MONITORING IN THE INDUSTRIAL CENTER

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A lidar complex for remote monitoring of atmospheric pollution over the city of Minsk is developed at the Institute of Physics of Belarus National Academy of Science of together with scientific, design and production organizations of Belarus. The spectral ranges of 0.27–0.45, 0.35–1, 4.5–5.5 and 9–11 μm are used for sensing of aerosol and gas polluting components of the atmosphere. The lidar systems are created and installed at the stationary lidar station for mapping pollution over Minsk and at the mobile lidar station for monitoring of air pollution near industrial objects.

The conception of using lidars in the system for monitoring of air pollution over an industrial center is based on using the lidar and local sensors for formation of the unit database on air pollution by aerosol and gas components. The methods and algorithms are developed for mathematical simulation of pollution transfer in the atmosphere. Input parameters of the models are the results of the database processing.

The lidar instrumentation, technique for measuring, methods for data analysis are examined in the field researches.

The ultraviolet spectral channel 0.27–0.45 μm is destined for monitoring of SO_2, NO_2, and O_3. The source of radiation is the narrow–band sapphire–titan laser (Ti:Sapphire, SF-131A, produced by SOLAR TII) with pumping by Nd:YAG laser (LS–2137, LOTIS TII). The pulse energy is 3–5 mJ in the range 270–310 nm at the spectral width of the generated radiation less than 0.03 nm. Systematic investigations of tropospheric ozone layer are started in 2000 by means of the lidar system based on the Ti:Sa laser.

The infrared channels 4.5–5.5 and 9–11 μm are based on the CO_2 laser with reduplication of the radiation frequency. The concentrations of CO, CO, NH_3, C_6H_6, and H_2O are measured by the path method.

The multiwave radars with the range 0.35–1.06 μm are used for monitoring of air polluton by aerosol over industrial centers.

C3-02

STUDY OF CRYSTAL ORIENTATION IN CIRRUS CLOUDS BY LIDAR METHOD

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An important feature of cirrus clouds is that their particles have a pronounced anisotropy of properties and a preferred orientation in space. Particle orientation is controlled jointly by such gross factors as aerodynamic and gravity forces. These cause the plate (columnar) crystals to orient their axes perpendicular (parallel) to the horizontal plane. Also lying in the horizontal plane are directions along which the axes of elongated particles are predominately oriented. Possibly, such directions form under impact of electrostatic forces.

In the report we summarize ten years of cirrus cloud sensing data obtained using high-altitude polarization lidar. The measured backscattering matrices (BSMs) were interpreted using a BSM model for elongated axially symmetric particles.

It is shown that in the cirrus clouds, typically about 2 km in vertical extent, particles with preferred orientation are largely concentrated near cloud bottom and decrease in number with height within the cloud. Crystal orientation varies with season: it is most stable in winter and summer. From analysis of multiyear data it follows that high-level clouds usually form in warm season, consistent with classical meteorological observation data.

The work, performed using Lidar instrument (reg. N 06-21), is supported by the Russian Fund for Fundamental Research (through the grant P98-02-03031) as well as by the Ministry of Science of the Russian Federation.

C3-03

LIDAR SIGNAL STRUCTURE FROM REMOTE AEROSOL FORMATION CONSIDERING DOUBLE SCATTERING

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As is well known, the power of doubly scattered component of lidar signal depends on the particle size distribution of the study aerosol volume; and this effect is most appreciable for the component of lidar signal determined by the diffraction component of scattering phase function.

In this report, the analytical expressions derived by ourselves for the power of lidar signal are analyzed to identify possible ways of extracting, from the total lidar signal, the component that depends on the microstructure of aerosol cloud located at different distances from lidar. In addition to theoretical considerations, numerical simulation results are also provided.

The work is supported by the Russian Fund for Fundamental Research (under grant P98-02-03031).

C3-04

LIGHT BACKSCATTERING BY HEXAGONAL ICE CRYSTALS

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Backscattering of light by hexagonal ice columns and plates has been calculated by means of a ray-tracing code. It is shown that backscattering by the hexagonal ice cylinders at their arbitrary orientations is caused by a peculiar corner reflector effect. A huge peak of backscattering is found for the tilt of both hexagonal ice columns and plates at the angle of about 32.5° between the principal axis of a particle and incidence direction. This peak has been explained by multiple total internal reflections inside the crystals. The obtained results on backscattering efficiency allow for calculating backscattering by an ensemble of the hexagonal cylinders of various sizes, shapes and orientations. Slant lidar remote sensing of cirrus clouds for discrimination between oriented columns and oriented plates is suggested as an application of the results obtained

C3-05

ALTITUDE PROFILES OF CLOUDY AND AEROSOL CHARACTERISTICS IN THE TROPOSPHERE ACCORDING TO SATELLITE LIDAR MEASUREMENTS

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In period from September 27, 1996 to July 4, 1999, over 50 nighttime satellite observations of earth-atmosphere system have been performed using Alisa lidar [1], installed in Priroda module onboard Mir space station. In the observations, the length of subsatellite track ranged from 2400 to 10000 km. The spatial resolution of lidar measurements was 150 m vertically and 960 m in along-track and 40 m in cross-track directions. First results of the field experiments have been presented elsewhere [2].

In all, over 240 thousands of altitude profiles of cloud and atmospheric backscattering coefficients have been collected during observations. As an example, in the report we present the processed altitude profiles of the mass concentration of maritime and continental aerosols in the troposphere and the vertical stratification of thin clouds.

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C3-06

STUDYING MICROSTRUCTURE OF THE STRATOSPHERIC AEROSOL BY LASER SOUNDING DATA

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The results are presented of the analysis of the data of systematic lidar observations carried out after Mt. Pinatubo eruption at the lidar station of the Institute of Physics of Belarus National Academy of Science (Minsk, 53.85° N, 27.5° E) and at the lidar station of Institute of Geophysics of the Academy of Sciences of Poland (Belsk, 51.83° N, 20.78° E). Sounding of the stratosphere was carried out at the wavelengths of 532 and 1064 nm. Depolarization of the lidar signal was measured simultaneously. The experimental data were obtained on the temporal variations of the optical parameters of the stratospheric aerosol layer since revealing the disturbance of the aerosol layer till its relaxation to the background state.

The technique for data processing was aimed at the study of variability of the stratospheric aerosol microstructure. Comparison of the backscattering ratio profiles at two wavelengths and the backscattering depolarization profile made it possible to follow the dynamics of the aerosol particle size and to reveal the non–spherical particles at the initial stage of the aerosol cloud formation.

The coarse aerosol fraction was observed at the end of 1991 and beginning of 1992 at the height of 15–22 km. The high backscattering depolarization degree is evidence of their non–spherical shape. The results of subsequent observations made it possible to follow the process of sedimentation of the coarse fraction and destruction of the stratospheric layer.

C3-07

STUDY OF AEROSOL AND WIND FIELDS IN ATMOSPHERIC BOUNDARY LAYER OVER BAIKAL LAKE BY REMOTE METHODS

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The report presents study of vertical profiles of scattering coefficients and wind speed and direction in the atmospheric boundary layer, inferred from measurements as part of the 24-h lidar and balloon-sonde experiments over Baikal Lake in summers of 1998-1999. The analysis revealed complicated altitude structure of aerosol fields, primarily caused by complex character of air circulation over the mountain valley. According to the estimate of the vertical sizes of circulation cells, their bottoms are at height 300 m and tops at heights between 1000 and 1300 m. Analysis of balloon-borne measurement data revealed a mechanism of distribution of wind fields in the eastern branch of air circulation over Baikal Lake.

We performed correlation analysis of diurnal variations of the profiles of scattering coefficients; in most cases, no relationship to near-ground measurement data has been found.

The work was supported by the Russian Fund for Fundamental Research (through the grants 99-05-79019, 98-05-031777, and 00-05-81164).

C3-08

VERTICAL PROFILES OF AEROSOL SCATTERING IN UPPER ATMOSPHERE ACCORDING TO ULTRAVIOLET OBSERVATIONS FROM SPACE WITH INSTRUMENTAL SPATIAL AVERAGING TAKEN INTO ACCOUNT

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The report discusses the retrieval of aerosol scattering properties between 50 and 100 km altitudes, based on measurements in the upper atmosphere made by satellite telescope from astrophysical station Astron by the method of atmospheric limb sensing at ultraviolet wavelengths 273 and 280 нм. In the work, the parameters of aerosol scattering are retrieved by solving inverse problem of atmospheric remote sensing with account of spatial (altitude) instrumental brightness smoothing. The retrieval of instrumental function (i.e., point spread function (PSF)) of satellite telescope onboard astronomical station Astron, based on extra-terrestrial observations of Earth and Moon are discussed elsewhere [1].

The obtained results have been compared with data of work [2]. It was found that, for observations from altitude of 100,000 km, the application of PSFs has almost no effect on altitude profiles of aerosol scattering; whereas for altitude 180,000 km, their use causes the unimodal aerosol scattering curve to degenerate into two peaks at heights 80 and 93 km.

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C3-09

AEROSOL CHARACTERIZATION WITH ADVANCED AEROSOL LIDAR FOR CLIMATE STUDIES

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A transportable scanning multiwavelength lidar has been installed for the independent and simultaneous determination of the particle backscatter coefficient at 6 wavelengths between 355 and 1064 nm and of the particle extinction coefficient at 355 and 532 nm. The physical particle parameters including the complex refractive index are retrieved from the optical data by an inversion scheme based on the Tikhonov's regularization technique. The optical and physical parameter sets serve as input in radiative transfer calculations to estimate the radiative forcing of the particles at the top of the atmosphere and at the surface. Quite different particle properties could be observed during the Aerosol Characterization Experiment (Portugal, 1997), the Lindenberger Aerosol Experiment (Germany, 1998) and the Indian Ocean Experiment (Maldives, 1999-2000). We present measurement examples which demonstrates this approach of comprehensive aerosol characterization.

C3-10

ULTRAVIOLET OBSERVATIONS FROM SPACE INTO A TRACE EFFECT OF SPACE SHUTTLE LAUNCHES ON AEROSOL AND OZONE OF THE EARTH'S UPPER ATMOSPHERE

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The report discusses observations of the effect of Space Shuttle launches on aerosol and ozone of the upper atmosphere. They are made by satellite telescope from astrophysical station Astron by the method of atmospheric limb sensing at ultraviolet wavelengths between 255-280 nm. The previous papers [1, 2] addressed Space Shuttle launches from Cape Canaveral on April 6, 1984. Here, those works are expanded upon to include observations of launch on April 12, 1985.

The obtained data confirmed that the Space Shuttle launches give rise to an extended, long-lived aerosol layer at altitudes around 100 km. In contrast to previous studies, in observations considered here the measurement line-of-sight tangent points were located across the active flight track, which made it possible to determine that the characteristic cross-sectional size of anthropogenic aerosol layer was ~ 900 km; although, the perturbation effects were evident in the region with up to 1500 km cross-sectional size.

As in previous studies, we failed to detect any effect of the launches on aerosol scattering properties at heights from 50 to 85–90 km and on ozone layer between 55 and 65 km altitudes within 2 h of the launch.

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C3-11

SPECIFIC FEATURES OF VERTICAL DISTRIBUTION OF STRATOSPHERIC OZONE OVER TOMSK ACCORDING TO DATA OF MULTIYEAR LIDAR OBSERVATIONS

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In the report, we present results of lidar monitoring of ozonosphere over Tomsk for the period 1996–2000. The obtained series of measurement data had been used to analyze the specific features of vertical ozone distribution (VOD), as well as vertical temperature distribution (VTD) in the stratosphere; for this, we used the mean nighttime profiles, obtained simultaneously in the altitude range from 13 to 35 km. To provide simultaneous VOD and VDT measurements, the remote sensing of ozone and temperature was performed at wavelengths 308/353 nm and 353 nm (by the method of differential absorption and method of molecular scattering, respectively).

By example of profiles averaged over February–March (the months of maximum ozone variability and ozone content in the stratosphere) of 1996–1999, we analyzed interannual VOD variations and found that, as is commonly observed in the midlatitude stratosphere, there are distinct quasi-biennial oscillations, most notable in the ozone maximum. Interestingly, in years with larger VOD values (1996 and 1998) there also occur higher temperatures, and vice versa (1997 and 1999). Correlation analysis of VOD and VTD has revealed the presence of a significant positive correlation in the layer 18–25 km, and a significant negative correlation at heights of about 13 km. The calculated trends of altitude distribution of ozone content and temperature in the stratosphere exhibit marked decrease (increase) of ozone above (below) 20 km and cooling at heights 20–30 km.

A comparative analysis of VOD has been performed for the winter and summer seasons 1997/98 – 1998/99 and 1998 – 1999. It was found, in particular, that when the winter and summer VOD profiles intersect at a height 25 km, above (below) this level the ozone content is markedly larger (smaller) in summer than in winte

C3-12

OPTIMIZATION OF LIDAR MEASUREMENTS IN UV SPECTRAL RANGE AND CALCULATION OF GAS CONCENTRATION VERTICAL PROFILE

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A computer program has been developed to estimate numerically the error of determining O_3, H_2O, SO_2, NO_2, HNO_3, H_2O_2, and N_2O_5 concentrations by the method of differential absorption of UV radiation and reconstructing, from these measurements, their altitude distributions.

We analyzed the error of gas concentration measurements, arising from inaccuracy of measuring lidar returns, uncertainty in atmospheric gas composition and aerosol scattering and extinction properties, and uncertainty in atmospheric thermal state. By minimizing this error, for different altitudes we determined optimal remote-sensing parameters: (a) wavelengths of sensing pulses, both at the absorption line center and outside the line; (b) number of pulses at each wavelength for a fixed total number of pulses; and (c) required spatial resolution of recorded signals.

The altitude profiles of gas concentrations were reconstructed using the method of differential absorption and solving a system of lidar equations in two ways: either through numerical differentiation of recorded signals, or using Tikhonov's regularization technique. In both cases, the altitude dependence of measured signals and calculated gas profile can be smoothed as required.

These procedures are implemented as a computer program in C++ language; it can be run under Windows 98 and has standard graphical interface, allowing for data input as well as displaying and filing the calculated results.

C3-13

ANALYTICAL MODEL OF SPECTROSCOPIC CW-WM-LD-DR-LADAR

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Most of the remote laser-diode gas analyzers used currently are based on the spectroscopic method of wave modulation (WM). These gas analyzers are portable, economical, sensitive, and selective but, at the same time, they cannot provide information on the spatial distribution of analyzed gas along the studied sensing path.

In the report, we present results of development of the theoretical model and numerical simulation of continuous-wave (CW) spectroscopic ladar designed by ourselves; it has good depth resolution (DR) and is based on the laser diode (LD) transmitter. The developed model is used to construct the calibration absorption functions for calculation of gas concentration form measured and processed ladar returns. Sensitivity of CW-WM-LD-DR-ladar to admixture concentration is estimated, together with some other tactical system parameters. We studied how the parameters of modulation of laser radiation and the parameters of absorption line contour for the studied gas influence the return signal characteristics. The amplitude of modulation of laser wavelength has been optimized. Measurement techniques and signal processing algorithms have been developed to calculate the spatial distribution of the studied gas.

C3-14

ESTIMATE OF RANGING LIMIT FOR DA LIDAR BASED ON CO_2 LASERS

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Lidar ranging limit is numerically estimated for atmospheric sensing by IR differential absorption lidar based on CO_2 lasers. We analyzed different factors influencing signal-to-noise ratio of return signals, namely, energy and power of sensing pulses, field of view and spectral passband of detector, area of receiving aperture, NEP of detector, and attenuation of radiation by the atmosphere. As an example, we considered ethylene sensing (at 10P14 line) in three lidar operation modes (aerosol backscattering and diffuse and specular reflection from topological targets) and found that the lidar ranging limit depends significantly on NEP value of used detector, and that it increases logarithmically as energy (peak power) of sensing pulses increases. At the same time, the detector field of view in the range 0.1–10 mrad is found to influence weakly the lidar ranging limit once a narrowband ($\Delta\lambda \sim 200$ nm) filter is used. For different spectral lines of lidar radiation, we determined the lidar ranging limit in measurements employing tunable TEA CO_2 laser (10 J, 100 MW, 85 spectral lines) developed for use as part of IR lidar. For unit signal-to-noise ratio, lidar ranging limit is calculated to be 10 km in aerosol backscattering operation mode, 20 km in measurements of diffuse radiation, and 40 km in measurements of specularly reflected radiation from topographic targets.

C3-15

LIDAR DETERMINATION OF POWER RELATIONSHIP BETWEEN ATMOSPHERIC BACKSCATTERING AND EXTINCTION

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It is no simple problem to obtain an adequate description of two characteristics of the atmosphere from one lidar equation. New schemes are proposed to convert the backscattering signals measured by lidar system. These schemes give the possibility of

the integration of lidar signals. Power function was used to describe the relationship between backscattering and extinction coefficients on the basis of data obtained near St.Petersburg. The solutions of the sets of the equations written for different directions and beampaths segments are used to find the average optical coefficients and the standard deviations of unknown parameters. The standard deviations are minimized to determine the boundary values and the relationship between the coefficients. Experimental data obtained by ruby lidar were used for the investigation of the schemes. The investigation revealed good prospects of the approach.

C3-16

ARCTIC HAZE, CLOUD EMISSIVITY, AND CLIMATE WARMING

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The Arctic Ocean's ice pack thickness and open water fractions have long been suspected of being sensitive to polar cloud and surface albedo feedback mechanisms (Maykut and Untersteiner 1992), but until recently the sensitivity of the radiation balance to cloud microphysics was thought to be modest (Curry and Ebert 1992). However recently Stone (1997) has demonstrated an unexpectedly strong and intimate link seasonally controlling surface temperature (T_s) namely, low cloudiness, the near surface temperature inversions, and Long Wave Downwelling (LWD) radiation. . Given that some seventy- percent of the total radiation received annually is LWD (Maykut and Church 1973), such sensitivity should perhaps not be entirely a surprise. However, recently Garrett et al. (2000) have shown a strong link between arctic haze pollution, arctic cloud microphysics, and LWD. The aerosol-induced changes in cloud microphysics are such that LW cloud emissivity can be substantially increased.

The cloud microphysical changed being observed in the Arctic Haze impacted clouds exactly mirror those observed when ship exhaust aerosols mix upward into clean marine stratus clouds to form long-lived "Ship Tracks" (Radke et al. 1989, King et al. 1993 and 1995). Droplet concentration increases the optically effective droplet radius decreases, drizzle halts, and long wave cloud emissivity increases.

In the winter time arctic such cloud microphysical changes could lead to sudden warmings such as observed by Persson et al. (1999). Simple calculations suggest emissivity changes of ten percent or more and resultant changes in T_s of 5–10° C.

As a result of these observations, we are reviewing data from the National Oceanic and Atmospheric Administration (NOAA) Global Monitoring for Climatic Change (GMCC) site at Point Barrow, Alaska for cases where observations of the arrival of arctic haze aerosols are linked to sudden or anomalous increases in T_s and LWD. Our initial review of this extensive data set is both encouraging and dramatic. Tens of cases per year are being found where, with the advection of a polluted airmass to the station and an increase in the aerosol light scattering coefficient of about an order of magnitude, T_s then increases more than 10° C after an as yet poorly defined lag period.

Case studies further linking cloudiness, LWD, T_s, and aerosols will be presented, as will our efforts to establish broader climate relevance of this aerosol-cloud-climate forcing mechanism.

C3-17

LIDAR MEASUREMENTS OF THE VOLUMETRIC BACKSCATTERING COEFFICIENT OVER NORTH TIEN-SHAN

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Results of laser sensing of the atmosphere under mountain conditions are discussed. These conditions ensure one of the world best astronomical climates, with high atmospheric transparency and almost no urban effect on air pollution and nighttime atmospheric illumination.

The main radiative parameters of lidar are: energy per pulse is 0.01–0.13 J; pulse width at half maximum is 10–20 ns; beam width at the 0.9 energy level is 0.6 cm; and wavelength is 532 nm. We used, as a receiving antenna of lidar, a mirror telescope with efficient mirror surface 1.2 m in diameter.

We analyzed time variations of volume backscattering coefficient, detected up to 10–80 km altitudes. Studied were the atmospheric layers with thickness from 0.9 to over 25 km. It was noted that, the thicker the atmospheric layer, the greater the probability of finding, in variations of volume backscattering coefficient at fixed altitudes, the 2.5–2.0-h long periods (e.g., variations with periods of about 170- and 160-min have been most frequently observed).

C3-18

THE MASS SPECTROMETRY OF VAPORISATION BY THE LASER RADIATION OF THE AEROSOL PARTICLES (ANALYSIS OF ARTEFACTS)

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Mass spectrometry analysis of vaporisation by the laser radiation of the aerosol particles (MSAVLAP) is widely used for the measurement of the chemical composition of aerosol particles.

Below the results of artefacts analysis for this method are presented.

The main source of mistakes of MSAVLAP is incompleteness of the evaporation of aerosol particles by laser radiation in the ionisation chamber of the mass spectrometer. It may be evaporated only surface skin layer of the particles ($|m|>>1$) or small part of particle volume near the main maximum of the laser radiation inside of particle.

It is shown that standard method of the interpretation of the MSAVLAP data may be used in the closed diapason of the parameters of the particles and laser radiation.

These calculations for the particles from corundum, SiO_2, soot, a-Fe_2O_3, NaCl, CuO, meteorite substance are executed.

The improving of the precision of the measurements may be reached by the involving of the optical data for scattering of the evaporated particles.

C3-19

REMOTE ACTIVE SOUNDING OF THE DROPLET SIZES BY SENSING OF THE THIRD HARMONIC GENERATION INSIDE THE PARTICLES FOR FEMTOSECOND LIDAR RADIATION

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Over past decade , the femtosecond pulses was used for remote sensing of the aerosol. These experiments with neodim laser have shown the great efficiency of the generation of the third harmonic of laser radiation by water droplets. The indicatrix of third harmonic generation can not be explained by theory Mi.

The optical properties of the water droplets has been investigated by numeric calculation of the Mi series and by classical quasi-geometrical theory. The hot spots in droplet generates the third harmonic.

The geometry of the hot spots in the droplets are same for any the large particles.

Moreover the angle of the convergence of the laser radiation of droplets is similar to the angle width of the indicatrix of third harmonic generation owing to the lasing super generation.

The the relationship of the intensity of the main and third harmonics of the laser femtosecond lidar depends from the mean size of droplets may be used for the aerosol sizing.

C3-20

AN ADVANCEMENT OF THE DIAGNOSTIC POTENTIAL OF IONOSPHERE SOUNDING BASED ON ANALYZING DISPERSION DISTORTIONS OF THE REFLECTED SIGNAL

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This study expands upon previous work focusing on medium diagnostics using analysis of distortions of reflected signals. When ionosphere is sensed vertically in shortwave spectral range, the signal distortions primarily arise due to the slope of the amplitude-frequency response (AFR) of the radiochannel. A measured parameter of distortions is the frequency derivative of the modulus of reflection coefficient or, in other words, the ARF slope. Reference [1] demonstrated how ARF slope measurements can be used to verify adopted model of the spatial spectrum of ionospheric inhomogeneities and estimate the amplitudes of relative fluctuations of electron concentration and vertical inhomogeneity scale. Also given are results of processing of three measurement records acquired during one day. Results in all three records justify the use of power-law spectrum as a model of ionospheric inhomogeneities, consistent with general views on inhomogeneous ionospheric structure. In this work we analyzed experimental data obtained between March and June 1995. In the data, there are both portions which follow power law as well as those which do not. Upon inspection, we think the reason may be twofold. First, in some measurements, the level of signal distortions was too low to determine distortion parameter, namely AFR slope, reliably. Second, the other measurements were characterized, conversely, by

higher than normal level of signal distortions, leading to multibeam character of signals due to large-scale ionospheric inhomogeneities. Numerical simulation results supported the validity of multibeam hypothesis.

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C3-21

THE DEFINITION OF PARTICLES SIZE OF THE MARS AEROSOL LAYER USING THE RADIOMETER ITHERMOSCANI PANORAMAS GOTTEN DURING THE IPHOBOS -2I FLIGHTING

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Some of the double channel scanning radiometer Termoscan panoramas were interpreted as those arising in the presence of the aerosol layer containing ice particles in the Mars atmosphere. The radiation fluxes registered by the radiometer where the effect of the Mars surface is omitted shows that the ratio of radiation fluxes for visible light at scattering angle $Q = 177°$ and $Q = 179.5°$ for different regions in the Mars atmosphere is rather stable and is of the order of 1.08 – 1.14. The models of aerosol medium microstructure in the form of a polydisperse distribution of spherical particles as well as the form of systems of nonspherical particles of cubic and hexagonal forms of equal size (the hexagonal prism length is equal to its diameter) with a chaotic orientation in space have been used. The range of the theoretical ratio of radiation fluxes for spherical particles ($0.7 < r_{32} < 0.9$ mm), where r_{32} is the ratio of the third moment of the particle size distribution to its second moment, corresponds to the fluxes ratio range abovementioned. For nonspherical particles equal in size with the same values of r_{32} as for spherical particles the values of r_{32} appear somewhat smaller (~15%) than for spheres

C3-22

METHOD FOR INDUSTRIAL AEROSOL EMISSIONS CONCENTRATION CONTROL

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Lidar measurements of aerosol concentration in industrial emissions from plant stacks involve the following steps: transmission of the sensing radiation through the aerosol plume, recording of backscattered signals from different sections of the sensing path, and interpretation of measurement results to get optical and, then, microphysical parameters (concentration). The existing processing techniques mostly assume that the backscattering portion of the scattering phase function $g\pi(r)$ is constant throughout the sensing path, which is generally invalid when an aerosol plume is present along the viewing direction.

To simplify measurement procedures and reduce errors due to $g\pi(r)$ variations, we use backscattered signals accumulated along overlapping segments of the sensing path. This method includes measurements of backscattered signal accumulated on the $[r_i - \Delta R, r_j]$, $[r_i, r_j]$, and $[r_i, r_j + \Delta R]$ segments, where $[r_i\ r_j]$ is the plume width; and ΔR is the width of the region adjacent to the plume. Extinction coefficient averaged over the segment $[r_i\ r_j]$ is $\bar{\varepsilon}(r_i\ r_j)$.

$$\bar{\varepsilon}(r_i, r_j) = -\frac{1}{2\Delta R} \ln \frac{S_1}{S_2} \left(\frac{S_2 - S_3}{S_1 - S_3} \right)$$

where S_1, S_2, S_3 are the backscattered signals accumulated on these segments. The aerosol concentration in the plume is obtained using an appropriately adjusted calibration coefficient.

We show that this method is insensitive to strong $g\pi(r)$ variations at the plume boundaries. The mathematical simulation results are presented to verify the method.

C3-23

INTERPRETATION OF BACKSCATTERED SIGNALS IN MULTILAYER CLOUD SENSING

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The existing backscattered signal processing methods for retrieving optical parameters (extinction coefficients $\varepsilon(r)$ and transmission $T(r_i,r_j)$) mostly use the assumption that the lidar ratio $g\pi(r)$ is either constant throughout studied sensing path or varies slowly from one point to another. For multilayer clouds, this assumption generally fails, leading to large errors when the profiles of optical characteristics are reconstructed along a sensing path. In the report we consider a backscattered signal processing technique that alleviates considerably the influence of $g\pi(r)$ variations on accuracy of $\varepsilon(r)$ and $T(r_i, r_j)$ retrievals.

The method includes:

– detection of cloud layers (sections with constant $g\pi(r_i)/ g\pi(r_{i+1})$ ratios);

– backscattered signal correction in the neighboring layer to account for qualitative variations of medium composition (assuming that $g\pi(r_i)$ is constant within a layer) and variations of extinction properties from one point to another (algorithms of correction coefficient make use of backscattered signals accumulated on the overlapping sections of the studied sensing path);

– interpolation of correction coefficient to the intermediate sections between cloud layers; and

– reconstruction of the profile of optical characteristics from corrected and interpolated signals.

In the report, we present the results of numerical simulation of reconstruction of the optical characteristics from backscattered signals using the method proposed here.

C3-24

WIDE SPECTRAL BAND LASER SOURSE FOR UNIVERSAL LIDAR SYSTEM

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We explore the possibility of creating universal lidar system usable to solve main problems of remote real-time monitoring of atmospheric ecological state, i.e., determining natural/anthropogenic aerosol and gas concentrations. Most suitable spectral interval to monitor finely (coarsely) dispersed aerosol fraction is at the short wavelengths up to 200 nm (at wavelengths up to 10 μm or longer). The priority set of gaseous pollutants includes nitrogen, sulfur, and carbon oxides, as well as ozone, methane, and some other light hydrocarbons. Nitrogen oxides, ozone, and SO_2 are sensed between 280 and 350 nm, NO_2 can be determined from absorption at the visible wavelengths, methane in the near-IR, and the light hydrocarbons at the working wavelengths of CO_2 lasers. Our intent is to elaborate a broadband source with bandwidth from 0.2 to 14 μm on the basis of neodymium or holmium laser with a set of single- or multistage nonlinear frequency-changer crystals, either new or rarely used. The former include $LiInS_2$, $LiInSe_2$, $HgGa_2S_4$, GaSe, GaSe:In, GaSe:InSe, and $AgGaS_2K$ crystals, transparent to all or most of UV, visible, and near- and middle-IR radiation. The latter include LBO, CLBO, DLAP, KTA, KTP and BBO crystals of improved optical quality and large size; they are used in combination with well-known crystals normally utilized in the middle-IR. It is shown that, even near edges of considered wavelength range, efficiency of corresponding frequency changers may reach tens of a percent. The working parameters are: emission line width is 0.1 cm^{-1} or narrower, pulse duration is 5–20 ns, and pulse repetition rate is up to 1 kHz with 1–50 mJ energy per pulse; which, combined with good performance for small weight and size, makes these crystals indispensable to create universal movable lidars operating up to ranges 1–10 km. In the report, the results of the model and experimental studies of frequency changers are discussed.

C3-25

PERTUBATION FEATURES OF A TOTAL OZONE FIELD BY INTENSIVE ATMOSPHERIC VORTEXES FROM TOMS SPECTROMETER DATA

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Using data of Total Ozone Mapping Spectrometer (TOMS), we analyzed perturbations of the total ozone field by 1998 tropical cyclones in three regions of active cyclogenesis: Atlantic and northwestern and northeastern Pacific. The ozone field perturbations were defined as deviations from (20-year) mean value of total ozone.

We expand upon an earlier work and study the dependence of magnitude and spatial extents of negative ozone anomalies on tropical cyclone characteristics; also we compare perturbations for depressions developing into storms and non-developing depressions, and analyze regional features of total ozone perturbations.

It is shown that negative ozone anomaly at the stages of tropical storm and typhoon (hurricane) may reach tens of Dobson units in magnitude and several hundred kilometers in size. The ozone anomaly is determined by both tropical cyclone intensity (maximum speed of sea-surface wind) and by the size of the region of wind storms.

It is found that, for tropical cyclones of the northwestern Pacific at the depression stage, the characteristics of ozone anomalies depend on whether or not the depression develops into storm. For most powerful 1998 typhoon (Rex) at the depression stage no negative ozone anomaly was at all observed. In the report, possible physical causes for these specific features of total ozone field perturbations are discussed.

The work is supported by the Russian Fund for Fundamental Research (under grant 99-05-64040).

C3-26

SPECTROSCOPIC MEASUREMENTS OF WATER VAPOR, METHANE AND CARBON OXIDE CONTENTS SPATIOTEMPORAL VARIABILITY IN THE ATMOSPHERE

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We present results of simultaneous measurements of water vapor, methane, and carbon monoxide abundances in atmospheric columns over Petergof, Zvenigorod, and Obninsk in July-August 1999. The three-station network measurements have made it possible to estimate the spatiotemporal variations of each of these atmospheric gas constituents over European part of Russia; we plotted these results on the latitude-day-abundance diagram applying splines to diurnally mean values of gas abundances.

As expected, water vapor content has the largest spatiotemporal variations in the atmosphere. The measurements showed that in July, over all European part of Russia the atmospheric water vapor content varied slowly, from 1.8 to 2.2 g/cm^2; while in September, under conditions of westward air transport, it varied in a wave-like fashion, from 1.5 to 2.0 g/cm^2, probably because of intrusion of humid air masses from west. Time lag between occurrences of maximum values of water vapor content at 60 and 55° latitudes is nearly 3–4 days, from which we determined the predominating direction of air mass transport in the region. From the data it is obvious that, the larger the number of spectroscopic measurement sites available to perform monitoring of atmospheric water vapor abundance at locations widely spaced in latitude, the higher the accuracy of estimates of air mass transport speed and direction.

The work is supported by the Russian Fund for Fundamental Research (under grants 98-05-65586, 99-05-64275б, 99-05-64925, and 99-05-79059).

C3-27

TEMPORAL VARIABILITY OF METHANE, CARBON OXIDES AND NITROGEN MONOXIDE IN AIR NEAR THE GROUND

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The report presents observational data on methane (CH_4), carbon dioxide (CO_2), carbon monoxide (CO), and nitrogen monoxide (N_2O) in the near-ground air samples taken in Obninsk between 1998 and 2000. The measurements are made using optical gas analyzer consisting of Fourier transform spectrometer with spectral resolution 0.5 cm^{-1} and multipass optical cell with base 1 m and with 30 m thick absorptive layer. The CH_4, CO_2, CO, and N_2O concentrations are determined by the method based on interpretation of infrared absorption spectra using spectroscopic database of vibrational-rotational line parameters "HITRAN-96".

The observations showed that CH_4, CO_2, CO, and N_2O concentrations in the near-ground air layer vary both during day and from one day to another, because air samples are influenced by local sources and sinks of both natural and anthropogenic origins. Normally, CH_4 vary by about 0.2 ppmv, CO_2 by 20 ppmv, CO by 250 ppbv, and N_2O by 30 ppbv. When temperature inversion occurs in the near-ground layer, the CH_4, CO_2, and CO variations are several times larger than normal. Most strong variations are found for carbon oxide whose concentration in the near-ground air reaches levels exceeding maximum permissible concentration for residential areas of populated regions.

In the obtained data, the minimum values of CH_4, CO_2, CO, and N_2O concentrations are used to determine the seasonal variations of these atmospheric gas constituents.

The work is supported by the Russian Fund for Fundamental Research (under grants 98-05-64072 and 99-05-64275).

C3-28

OZONOMETRIC COMPLEX FOR SATELLITE METEOR. ULTRAVIOLET SPECTROMETERS BUFS-3 AND BUFS-4

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Institute of Experimental Meteorology (IEM) ozone measurement system is developed to study ozonosphere of Earth from satellites of Meteor series. The system consists of two instruments: (a) ultraviolet nadir-looking satellite spectrometer BUFS-3 for measurements of total ozone content (TOC), vertical ozone distribution (VOD), and cloud top height (CTH); and (b) mapping sensor BUFS-4 for TOC and CTH measurements in scans perpendicular to orbital plane.

In comparison to predecessor instruments (BUFS-1 and BUFS-2) and American analogs (SBUV and TOMS), BUFS-3 and BUFS-4 additionally include channels in molecular oxygen absorption bands for CTH measurements. The CTH data can be used to increase substantially the accuracy of ozone measurements; moreover, they are important in their own right.

BUFS-3 measures the spectral intensities in 15 channels around wavelengths 252.0, 273.5, 283.0, 287.6, 292.2, 297.5, 301.9, 305.8, 312.5, 317.5, 331.2, 339.8, 349.0, 738.0, and 762.0 nm.

Optical scheme of the instrument includes double monochromator with zero dispersion, based on spherical diffraction gratings 1200 groove/mm.

Duration of measurement cycle is 20 s.

Field of view is 8° by 8°.

BUFS-4 has 7 channels centered at 312.5, 317.5, 331.2, 339.8, 349.0, 738.0, and 762.0 nm.

Scan mirror is directed in 3° scan steps to produce a ±52° swath relative to nadir.

Field of view is 3° by 3°.

Scan duration is 7 s.

C3-29

CARBON OXIDE CONCENTRATION MONITORING NEAR THE FIRES ON MEASUREMENTS OF MEDIUM TRANSMITTANCE

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We discuss the possibility of determining carbon monoxide concentration from transmittance measurements in a gaseous medium without determining temperature profile near the heated object. This can be done at points with weak temperature dependence of CO absorption coefficient. We demonstrate how these points can be identified near the center of fundamental vibrational CO band using specific shape of the spread function of receiving system. Situations with particular instruments are investigated and difference in retrieved CO concentration is estimated. A numerical experiment is performed and the numerical results analyzed.

C3-30

THE DEFINITION OF CONCENTRATION SPATIAL DISTRIBUTION PARAMETERS OF THERMODYNAMICALLY INHOMOGENEOUS GAS VOLUME USING INTEGRATED PERFORMANCES OF OPTICAL RADIATION PROPAGATION

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We explore a possibility of determining concentration-field parameters of a particular component of gas-phase mixture from spectral dependence of integrated characteristics of optical radiation propagation. Possibilities for linearizing the problem are considered in specific cases of thermodynamically inhomogeneous media with corresponding sensing-path geometries. A comparative analysis is made using information about two quantities, the absorption line contour as a function of pressure and temperature and integrated absorption rate as a function of temperature. The main preference criteria are considered to be requirements of anticipated experimental setups. A numerical experiment is made in which a thermodynamically inhomogeneous gas volume is simulated using available spectral line data bases. From results thus obtained, it is possible to formulate recommendations concerning resolution, shape of the spread function, and spectral intervals for the used radiative sources and receivers.

C3-31

LASER PROBING OF UPPER WATERS IN THE ATLANTIC AND THE EUROPEAN SEAS

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The method of ship-based sea sensing by ultraviolet laser and corresponding instrumentation have been developed jointly by Institute of Oceanography of Russian Academy of Sciences and by Higher Energetic Institute at State Scientific Center of Russian Federation. A ship-based lidar with excitation wavelength 347 nm was used to induce Raman scattering in sea water near 397 nm wavelength, fluorescence of dissolved organic substance of natural origin (yellow substance) and oil products (DOSP) at wavelengths between 400 and 560 nm, and fluorescence of chlorophyll and phytoplankton at 685 nm.

Most of the previously developed techniques employ a normalization of admixture fluorescence signals by Raman scattering (RS) signal for pure water. However, our measurements showed that RS signals sensed in semi-infinite aquatic medium are not stable, depend strongly on water properties (such as efthrophy and pollution level among others), and vary by a factor of 10 or more from one oceanic region to another. Therefore, the RS signal alone cannot be used as a "reference" signal, and some other parameters of water mass are required to perform normalization. This motivated the development of a new theory and new algorithm for processing of ship-based sea sensing data. So, a few formulas have been derived that relate sea-sensing parameters, such as SR signals, DOSP and chlorophyll fluorescence characteristics in different spectral regions, and energy of laser pulse, to the sought parameters, namely DOSP and chlorophyll concentrations and optical index of water type m.

The ecological lidar was calibrated in waters of Ionic and Sargasso Seas.

The measurement results were then mapped to show DOPS and chlorophyll distributions along the ship track. In the New York –Las Palmas transect, the DOPS concentration in the optical units (i.e., absorption coefficient at 347 nm) varied from 0.003 m^{-1} (Sargasso Sea) to 0.92 m^{-1} (New York Bay), i.e., by a factor of 300. The chlorophyll concentration, in this same transect, varied from 0.016 mg/m^3 (Sargasso Sea) to 3.3 mg/m^3 (Canary upwelling), i.e., by a factor of 200, with 36% standard deviation from the values measured for the samples by standard method. It was found that, going from Midatlantic Ridge to the east, DOSP concentration increased faster than chlorophyll content. Possibly, this is because of westward transport of Canary upwelling waters by the Northern trade-wind stream.

In Mediterranean Sea, the DOSP concentration varied from 0.013 m^{-1} (Ionic Sea) to 1.83 m^{-1} (Neapolitan Bay), suggesting most polluted waters are near Naples port.

The measurements also revealed that near large ports such as New York, Naples, Rotterdam, Istanbul, Piraeus, Lisbon, Havre, and Las Palmas the DOSP fluorescence exceeds the normal sea-water fluorescence level by 10-100 times or more.

C3-32

ESTIMATE OF OPTICAL STATE OF BAIKAL WATERS USING SENSING-PATH SPECTROSCOPIC MEASUREMENTS FROM ONBOARD HELICOPTER.

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Baikal Lake has unique ecological system whose remote monitoring, primarily based on satellite sensing information, is very difficult to make in real time because of unfavorable weather conditions. Despite the complicating high-cloud cover, we preformed an integrated spectroscopic survey of the lake from onboard a helicopter flying below the clouds. The helicopter instrumentation included two spectrometers, one for continuous record of the brightness ratio at two wavelengths along entire flight track, and the other for record of high-resolution measurements of the spectra of upward sea-surface emission at locations where the first radiometer signaled significant variations of interchannel brightness ratio. As far as circumstances permitted, in addition to spectroscopic measurements we also collected water samples from onboard the helicopter, for subsequent analysis of water chemical composition for the presence of optically active components. From the data obtained it follows that (a) the spectra of brightness coefficients (and, hence, the ecological state of the lake) are highly diverse and, for some part, are close to those of water reservoirs of the European part of Russia, not usually classified as "clean"; and (b) at locations where spectroscopic measurements detected abundant optically active ingredients, analysis of water samples has further revealed on both abundant chlorophyll A of phytoplankton and suspensions. Interestingly, in all analyses before those locations had generally been treated as clean. Summarizing, we think that the spectroscopic measurements in the visible range can be used as a sensitive indicator of the state of aquatic ecological systems with wide variability ranges of concentrations of optically active constituents

C3-33

ESTIMATION OF «YELLOW SUBSTANCE» CONCENTRATION IN SEA WATER USING DATA OF VARIOUS CONTACT AND REMOTE MEASUREMENTS

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Using data obtained in Canarian Upwelling, Black and Marmora Seas from board reseach ships of Shirshov Institute of Oceanology RAS the possibility of "yellow substance" concentration determination in productive and polluted waters by one of the four optical methods was shown.

The first method is based on the contact measurements of the vertical light attenuation coeffitient and diffuse light reflection coefficient in the spectral range 400-600nm with decsending devices. Using these data the spectrum of water absorbtion is calculated and the concentrations of phytoplankton pigments and "yellow substance" are estimated.

The second method uses remote measurements of the sea-water radiance coefficient spectra from board a moving ship with three-channel spectrophotometer giving the spectra of sea radiance, the adjoint sky area radiance and solar illumination of the sea surface. The water type optical index is calculated from the obtained sea water radiance spectrum, then using the appropriate classification the main natural admixtures concentrations are estimated.

According to the third method "yellow substance" concentration is estimated from the measurements of sea water fluorescense intensity in blue-green spectral band (~450nm) by laser remote sensing of water surface in UV.

The results of "yellow substance"concentration estimation in sea water by these three methods were proved by the comparison with the concentration measurements data obtained by the two-ray laboratory photometer in filtrated samples of sea water taken at the stations.

C3-34

THE SOME CHARACTERISTICS OF STRATOSPHERIC AEROSOL, OBTAINED BY SPACE SOUNDING TWILLIGHT AUREOLE OF THE EARTH.

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The iterative scheme and technique of a statistical regularization based on the scheme of non-linear programming were applied with the purpose of optimization of the solution within the framework of a sounding method of a twilight aureole of the Earth in approximation of single dissipation for the solution of the reconstruction task of vertical profiles of ozone's concentration and factor aerosols extinction. This procedures have allowed to reduce an error of recovery up to 3% in a profile points and to improve the precision of a profile and to receive a vertical structure of a restored component with a step up to 100m.

The following results were obtained by processing of outcomes of a series of the experiments which have been carried out in 1992-1994 with the help of a multichannel spectrometer "Spectr-256", located on orbital station "MIR": 1) there were retrieved vertical profiles of ozone's concentration and aerosols extinction with an error in a point of profile 3-10% and discrepancy 5-10%; 2) the cumulative size-distribution function of particles are constructed with an error discrepancy 30-40% for each high-altitude step. The analysis of the obtained outcomes has shown, that, at the moment of measurements the aerosol had, in main, one-modal size-distribution and placed in stratosphere by layers with width 1km. In altitude band of 50-55km the aerosol layer with width 2km was observed. In some measurements at altitudes 49-51km the aerosol was characterized two-modal size-distribution. The effective average size of particle was found in составлял 0.1-0.5mkm.

C3-35

ODRIS SOFTWARE FOR PROCESSING AND ANALYSIS OF UV-LIDAR DATA ON STRATOSPHERIC OZONE. ANALYSIS SUBUNIT

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Currently, we are developing the Ozone Data Retrieval and Informative System (ODRIS) software package that can be used for storage, processing and analysis of UV lidar sensing data on stratospheric aerosol. In this report we describe one of the steps of this development, the ANALYSIS unit of this software. It is designed for study of spatiotemporal variations of ozone profile and for their comparison with other measurement data (on temperature, scattering ratio, etc.). The accumulated multiyear lidar data on vertical ozone distribution will help one to identify physical relationships in the atmospheric processes over Tomsk and in ozone profiles and their variations. This can be done using, in addition to ozone profiles, data on aerosol stratification (scattering ratio) and temperature, among many others. The ANALYSIS subunit allows one to perform such combined analysis using many of its internal procedures. Basic mathematical (visual and statistical) principles of analysis are formulated and examples of ANALYSIS work presented.

C3-36

RAY-TRACING METHOD FOR JONES'S MATRIX OF CRYSTAL PARTICLES

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At present, a conventional ray-tracing method in the problem of light scattering by nonspherical particles has not been worked out, and authors used to compose their own calculation algorithms for these purposes. As a rule, the quadratic quantities of scattered fields – cross section and Mueller's matrix – are calculated by the ray-tracing methods. The wave phenomena such as diffraction and interference prove to be ignored in these approaches. In this paper, a ray-tracing method for Jones's matrix has been proposed where the wave level is considered and the wave phenomena are automatically taken into account. To check the method proposed, Jones's matrix has been calculated for hexagonal ice crystals, for which Mueller's matrices were calculated by the authors before. Then a transform of the Jones's matrix to Mueller's matrix calculated earlier allows us both to check the calculation algorithm proposed and to estimate the wave adjustments for the previous Muller matrices.

C3-37

INVESTIGATION OF INHOMOGENEITIES OF MARINE ECOSYSTEMS BY FLUORESCENCE AND BIOLUMINECENCE RESPONSES

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Chlorophyll-bearing living organisms emit red fluorescence light under exciting illumination. This response is frequently used to study inhomogeneous plankton distribution in oceanic ecological systems. At the same time, the property of a wide variety of living organisms, residing in seas, to emit green light under a mechanical impact is rather rarely used in practical applications. The bioluminescence of ecological systems has been studied with great success by the scientific group headed by academician Gitel'zon; they showed that, by sensing bioluminescence, it is possible to "visualize" the spatiotemporal plankton distribution. However, no attempts to compare spatial inhomogeneity measurements made simultaneously by fluorescence- and bioluminescence-based techniques have yet been made. Based on measurements in Pacific and Black and Mediterranean Seas, we have made such a comparison. We showed that the spatial inhomogeneity fields, derived from intensities of bioluminescence and fluorescence responses, strongly differ. An explanation for this is given in this report.

C3-38

FEATURES OF GASANALYSIS INVERSE TASK SOLVE BY USING OPO MEASUREMENTS

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Optical parametrical oscillators (OPOs) can be operated over most of the IR spectral range (2–5 μm). In this spectral region there lie the absorption bands of main atmospheric gases. However, the cost paid for the wider tuning range is non-monochromaticity (~0.3 cm^{-1}) of the spectral line of laser radiation, which precludes the concentration analysis of such measurements by traditional techniques (such as MNC, regularization, etc.). We think the problem can be solved in two steps involving (1) removal of the influence of instrumental function of laser radiation and (2) application of traditional techniques afterwards. We analyze different approaches to solving this problem and estimate their accuracy and sensitivity to measurement errors.

C3-39

OZONE PROFILE RETRIEVAL FROM DIRECT SOLAR RADIATION MEASUREMENT BY FTS. COMPARISON RETRIEVAL METHODS

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Solar radiation observed near the ground with help of Fourier Transform Spectrometer (FTS) is a powerful type of remote sensing experiment. The retrieval of column amounts and/or vertical profiles of atmospheric constituents are possible from

spectroscopic measurements of solar radiation with high resolution. In this report the some mathematical procedures and their computational realization for ozone profile retrieving in stratosphere is discussed. This task can be divided into two parts: Forward simulation (calculation model transmission of solar radiation through the model atmosphere) and Inverse problem (fitting other type of methods of results from or forward task or real measurements).

C3-40

SOME COMPARATIVE ANALYSIS RESULTS FOR TWO TYPES OF OZONE ANALYZERS

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Selection of an adequate gas analyzer with desired specifications is one of the primary goals in ozone-monitoring problem. Two types of ozone analyzers, ultraviolet and chemiluminescent, are currently in use, with only one usually adopted and the others abandoned as suspect.

In this work, we compare two types of ozone analyzers. We chose ultraviolet ozone analyzer, model 49, by Thermo Environmental Instruments Inc., and a chemiluminescent gas analyzer, model 3-02P. They both were tested both under laboratory and field conditions.

In laboratory tests, with ozone generator as ozone source, both instruments showed very good agreement. However, under real atmospheric conditions they have been seriously in odds. Upon analysis, we have found this discrepancy to be due to the presence of ultrafine aerosol fraction in the atmospheric air. Laboratory tests to quantify the influence of ultrafine aerosol on the instrument performance have revealed that the measurements by ultraviolet gas analyzer

C3-41

RESULTS OF COMPARISON OF DIFFERENT TYPES OF PHOTODETECTORS AND AMPLIFIERS-DISCRIMINATORS USED IN OZONE SENSING LIDAR

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Lidar sensing of ozone at the Siberian Lidar Station has been regularly performed since 1988 to present. For this period, several modifications have been made to the recording path of lidar to adapt to new photodetectors and new components appearing in the amplifier-discriminator circuitry.

In this report, we present the results of comparison of different schemes of lidar recording path that influence the retrieval of tropospheric and stratospheric profiles of ozone and temperature. Shown are the lidar returns and the profiles of ozone and temperature, obtained using different types of photodetectors operating in the photon-counting mode. The detectors have different quantum efficiencies at wavelengths 308 and 353 nm, as well as different signal-to-noise ratios. In the work, we made analysis and selection of photodetectors suitable for ozone sensing applications. In addition, we compared several schemes of amplifier-discriminator and their influence on retrieval of ozone and temperature profiles; we evaluated them and proposed an optimal configuration of the amplification path – PMT, amplifier, discriminator for use in ozone sensing lidar.

C3-42

BEGINNING THE MONITORING OF TOTAL OZONE OVER SOUTH-EASTERN REGION OF BAIKAL LAKE

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The first results of total ozone observations in the atmosphere over south-eastern region of Baikal lake, Istomino (52.17° N, 106.33° E) are presented. The observations have begun in summer of 1999 by the Department of Physical Problems, BSC SB RAS. A comparison of the data of in situ (ozonometer M-124) and satellite (TOMS/Earth Probe) measurements of total ozone has been carried out. An analysis of ozone and aerological data has also been performed.

C3-43

STRATOSPHERIC AEROSOL LAYER IN 1999–2000 ACCORDING TO LASER SENSING DATA OBTAINED AT SIBERIAN LIDAR STATION

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During extended periods of time, the optical characteristics of stratospheric aerosol layer (SAL) are determined by volcanic aerosol that persists in the stratosphere for a few years after explosive volcanic eruptions. By background SAL states are usually meant those with lowest stratospheric aerosol loading in periods of long-term absence of powerful volcanic eruptions. Using present-day facilities such as lidars, balloon sondes, and space-borne sensors, the lowest aerosol content in the stratosphere has been observed in 1979, 1989–90, and since 1997. Interestingly, in the last "new background period", since 1997 the stratospheric aerosol loading has been no larger, and at times even smaller, than in 1990–91, the years preceding Pinatubo eruption in June 1991; which does not support the existing hypothesis that the well-known anthropogenic factors are responsible for the increase of the background SAL mass and associated ensuing climatic changes. Stratospheric aerosol studies at the Siberian Lidar Station IAO SB RAS have been performed since 1986; upon analysis of these results, we have suggested (Zuev V.V. et al.// Atmos. Oceanic Opt., 1999, 12, 257–264) that, for the Northern Hemisphere midlatitudes, two features can be considered the criteria of the background SAL state, namely (1) the lack of significant differences between the seasonally (winter-summer) mean profiles of aerosol stratification and (2) a uniform exponential behavior of altitude aerosol distribution. Measurements during background period 1999–2000 do not contradict these criteria and match the 1990 observations in many respects. The mean summer- and wintertime profiles of the scattering ratio $R(H)$, which reflect the aerosol stratification, have nearly identical shapes; while the R values at the sensing wavelength 532 nm range from 1.05 to 1.1. The maximum of aerosol content at the Junge layer altitudes (19–20 km in summer and 16–17 km in winter at Tomsk latitude) is not well defined, indicating that the Junge layer is of volcanic origin.

The work, performed at the Siberian Lidar Station (reg. N 01-64), is supported by the Ministry of Science of the Russian Federation, and by the Russian Fund for Fundamental Research (under grant N 98-05-64267).

C3-44

ANALYSIS OF EFFICIENCY OF DIFFERENT SMOOTHING ALGORITHMS FOR LIDAR DATA PROCESSING

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The work intercompares different methods of smoothing the atmospheric lidar sensing data at different stages of retrieval of vertical distribution of ozone concentration. We present the results of numerical simulation of ozone concentration in the altitude range 15–35 km obtained using nonuniform smoothing of initial lidar returns and ozone profiles by the following methods: smoothing by running means, smoothing by running medians, exponential smoothing, smoothing by splines, and adaptive smoothing. It is demonstrated that the data smoothing procedures can influence significantly the spatial resolution of the altitude distribution of ozone concentration and interlevel correlation of ozone profiles. The possibilities of minimizing errors of ozone retrieval from lidar sensing data are discussed.

The work is supported by the Russian Fund for Fundamental Research (through the grant N 99-05-64 943).

C3-45

VARIATIONS OF SCATTERING RATIO IN THE MIDDLE ATMOSPHERE IN WINTER 1999/2000

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Analysis of results of the regular monitoring of the state of stratospheric aerosol and ozone, performed at the Siberian Lidar Station, has revealed the presence of pronounced scattering ratio variations between 24 and 32 km altitudes in the winter seasons. The measurements have been made using two stationary lidars: an aerosol (wavelength 511 nm, receiving telescope with the main mirror 2.2 m in diameter) and ozone (353-nm wavelength outside the ozone absorption band; receiving telescope with the main mirror 1 m in diameter). For these measurements, the statistical representativeness of lidar data was quite good up to 40 km altitude.

The variations of the scattering ratio had not been observed regularly, and had fairly random vertical structure. Most likely, the reasons for the observed random variations of the profiles of scattering ratio are twofold. First, this may be due to emergence, at these altitudes, of real aerosol formations, whose nature is quite difficult to explain. Second, the reason may lie in the methodological uncertainty of scattering ratio retrieval, namely in calibration of lidar returns against molecular scattering

component. Specifically, for calibration we used model values of the molecular backscattering coefficient; whereas in reality, the molecular scattering is proportional to the atmospheric air density which, in its turn, is linearly related to air temperature. That stratospheric temperatures do really vary was generally confirmed by direct temperature measurements. In this report, we present the results of observations of the scattering ratio variations, and explore likely causes of their occurrence.

The work, performed at the Siberian Lidar Station (reg. N 01-64), is supported by the Ministry of Science of the Russian Federation, and by the Russian Fund for Fundamental Research (through the grant N 98-05-64267).

C3-46

OBSERVATIONS OF VERTICAL NO2 DISTRIBUTION AND TOTAL NO2 AND O3 CONTENTS BY HIGH-SENSITIVITY SPECTROPHOTOMETER DURING POYMA 99 EXPEDITION

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The problem of atmospheric ozone is one of the priority research areas in the Institute of Atmospheric Optics SB RAS. Ozone is a strong absorber of ultraviolet radiation and, as such, it plays a key role in radiative and physical-chemical processes, determines the thermal regime of the stratosphere, and prevents biologically active hard ultraviolet radiation from reaching the earth's surface. Destruction of stratospheric ozone layer and formation and migration of ozone anomalies (ozone holes) over Antarctica, Europe, and Siberia have stimulated the establishment of worldwide monitoring network.

As part of the Poyma 99 expedition, the Institute of Atmospheric Optics SB RAS has provided a few instruments for study of the atmosphere. One such device was a high-sensitivity spectrophotometer with narrow (3-mrad) field-of-view receiving optics, designed for study of the total contents and vertical distributions of nitrogen dioxide and ozone.

This report describes the instrumentation, the measurement techniques, and the processed experimental data. The results of the measurements of total ozone and NO_2 contents, obtained during Poyma 99 expedition, are presented and compared with data, acquired at the Siberian Lidar Station at Institute of Atmospheric Optics SB RAS.

The work is supported by the Russian Fund for Fundamental Research and by administration of Tomsk region under grants p98-Siberia Nos. 98-05-153 and 98-05-154.

C3-47

REMOTE GAS ANALYZER DAN-1

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Remote-acting gas analyzer DAN-1 represents optical correlation instrument, based on recep-tion of direct and scattered radiation, both from natural and artificial sources of light. The analogue of the given instrument is the equipment DIV-1 and ECOL-1, elaborated earlier. The distinctive feature of the given device is the use of Kassegren telescope of mirror type with the diameter 27 sm that enables to get a spatial resolution of 1 м at the 3км distance. The signals formed on photodetector are transmitted to ADC, where they are digitated and set into PC, controlling the process of measurements. The whole equipment is bolted on the two-coordinate scanning platform. Parallel to optical axis of telescope television camera is installed with the variable focal length, allowing to get a direct picture of the observed object with different enlargement on the computer screen.

The testing of equipments DAN-1 is carried out in different meteorological conditions and at a different time of the day. Optimum conditions of probe thick gas plumes are revealed. The results of equipment testing with strong fluctuations of the observed signal and its correlating dependence on the transparency of smoke plumes are analysed.

C3-48

STRATEGY DEVELOPMENT OF PROBE OF THICK GAS PLUMES ON THE BASE OF USING OPTICAL CORRELATION ANALYZER

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The application of a remote control of the environment using effect of passive location on the base of optical correlation spectroscopic attracts greater attention for the last years that is connected with the absence of the high-priced lazer sources in the equipment. However, the real use of the given method came across the number of difficulties, connected with optical opacity of the majority of smoke plumes that made impossible their direct probe. In the given work new strategy of probe thick gas plumes with the use of correlating analysis of fluctuations of received signal for the first time is tested. Optimum geometry of probe with respect

to the radiator (sun, searchlight, lamp) is chosen. On the base of the analysis of concentrations of gas NO_2 in pipes of GRES-2 of Tomsk in different meteorological conditions the research work was done. The interpretation of the achieved results on the base of drawing near the little angular distance. It is marked that the best angles of probe correspond to a position of solar disk in the interval of angles 120–170°, measured out from the north direction. The optimized criterion of the choice of the initial parameters of probe is designed.

C3-49

APPLICATION OF THE POLARIZATION LIDAR FOR DETERMINING THE OPTICAL PARAMETERS OF CLOUDINESS

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Depolarization of the linearly polarized laser radiation by cloud particles is the information capacious parameter that characterizes the state of water in the cloud. The joint analysis of different polarization parameters provides the qualitative data on the cloud structure. At the same time, the methods of quantitative interpretation of these parameters practically were not considered earlier.

The sounding equation is derived in the first part of the paper on the basis of the results of theory of double scattering taking into account the multiple scattering for the radiation polarization characteristics. The reliability and boundaries of applicability of the equation are studied in the numerical experiment comparatively to the data of calculation by the Monte–Carlo method. The algorithm is proposed in the second part for joint reconstruction of the scattering coefficient and lidar ratio profiles. The questions of realization of the algorithm under conditions of a priori uncertainty in the cloudiness type are considered.

C3-50

THE ANALYSIS OF FRACTAL DIMENSION OF SPACE STRUCTURE OF THE GEOMETRICAL AND OPTICAL CHARACTERISTICS OF A CLOUDINESS

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One of the possible directions of development of the theory of radiation transfer through the inhomogeneous atmosphere is a creation of such an optical model of inhomogeneous clouds, which can take into account adequately the random geometry and inhomogeneous internal structure of clouds. At that the numerical investigations showed that the geometrical variations dominate above intraclouds variations of density. Moreover, it was shown last years that the radiation characteristics not in a smaller measure depended on the irregular vertical borders of clouds.

To account adequately the cloudiness stochastic geometry the fractal models of clouds are applied. Construction of these models is based on multiplicate cascade processes. The estimations of fractal dimensions of spatial structure of real cloud fields are used in such models. To study the cloudiness stochastic geometry the use of the aircraft or spacecraft lidar is rather prospective. We already obtained the similar estimations from the data of laser airplane sounding for the stratocumulus clouds of the bottom layer above the Western Siberia and above the Norwegian Sea. In the paper the results of the fractal analysis of cloud fields are presented. The analysis is based on the data of lidar under-satellite sounding from an airplane. Sounding was carried out on the program E-LITE in Western Europe. The joint estimations of fractal dimension parameters were obtained, which characterize the spatial structure of the top border fluctuations and optical thickness stratus cloudiness of the medium-level.

C3-51

RECONSTRUCTING OF GAS DENSITIES FROM MULTISPECTRAL LIDAR MEASUREMENTS BY OF MODIFIED METHOD OF DISCREPANCY

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One of the problems arising when using lidar methods for remote gas analysis of the composition of the atmosphere is the necessity of application of special processing algorithms for reconstruction of the gas concentrations at the multicomponent gas analysis.

The problem of determination of the gas concentrations from the results of multiwave lidar measurements is reduced to solving the system of linear algebraic equations, where the unknown values are the concentrations of gas components. The

difficulty in solving such a system is that the right parts of the equations are always known with a random error caused by the errors of measurements, instrumental noises, etc. The attempts to directly invert of the system of the equations of multiwave gas analysis under these conditions lead to the fact that the inverse operator is not stable, and small variations of the data of measurements result in big variations of the sought values. The way out of this situation is applying the a priori data on the smoothness of the sought functions and constructing the regularized solution. The accuracy of the solutions obtained depends on the value of the regularization parameter, the selection of which is the principal difficulty in applying the methods of regularization.

Modification of the method of discrepancy was used for obtaining the regularized solution. It was the combination of two methods: the method of discrepancy and selection of quasi–optimal parameter of regularization. The measurement noises in different channels can strongly differ from each other, so the specific parameter of regularization was used for reconstruction of the concentration of each gas.

Mathematical simulation for the number of spectral channels from 6 to 16 was carried out for testing the efficiency of the processing algorithms and estimating the accuracy of reconstruction of the gas concentrations.

The algorithm for selection of the regularization parameter based on the modified method of discrepancy makes it possible to reconstruct the gas concentrations at multiwave lidar gas analysis of the atmosphere with high accuracy.

C3-52

ESTIMATION OF SPATIAL VARIATIONS OF THE EARTH'S ULTRAVIOLET BACKGROUND FROM A BOARD OF THE ASTROPHYSICAL SPACE STATION ASTRON

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The report presents results of the study of daylight background ultraviolet radiation of Earth; it was measured by ultraviolet telescope from astrophysical space station Astron at fixed wavelengths between 273 and 285 nm in 1983–1988. Average scan duration is 5 min, and sampling interval is 0.61 s. On ground, synoptic-scale tracks have length about 1000 km; telescope spots are not equidistant and, on average, several kilometers apart; and ground footprint is less than 10x10 km.

Synoptic-scale variations of atmospheric spectral brightness from mean trends are found to be mostly within ±10%, consistent with results of Ref. [1] for wavelength 302 nm.

Fourier analysis has revealed the following. Mesoscale spatial variations of background ultraviolet radiation, corresponding to variations with periods from 10 km to 100÷200 km, should be less than 4% (i.e., less than the noise level in photon-counting mode of PMT). Unfortunately, large spatial periods translate to temporal power spectrum, in which the harmonics of 70-s guiding cycle caused by scanning are distinctly seen. Therefore, (a) the level of synoptic-scale variations of background signal actually must be less than 10%; and (b) it cannot be entirely ruled out that some of the peaks occurring in the power spectrum with periods 1-3 min are associated with variations of ultraviolet background radiation.

Reference

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C3-53

CURRENT STATE OF THE OZONOSPHERE OVER WESTERN SIBERIA

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Results of total ozone column (TOC) monitoring at the Siberian Lidar Station (56.5° N, 85.0° E), IAO SB RAS in Tomsk are presented. The measurements are performed with using standard ozonometers M-124. A statistical analysis of the measurement data shows that at present a steady growth of total ozone is observed in Western Siberia. Ozone increasing is more large in the cold half-year. During two last years the negative ozone deviations concerning long-term mean have not exceeded an extreme level of 2 s.d.; which has been in ozone holes.

Results of comparing data of in situ and satellite measurements of total ozone over Tomsk are also presented. Ones show a good agreement which on an average does not exceed more than 3%. Using these data, the temporal series of total ozone for both cold and warm half-years since 1979 were obtained (see a figure). A comparison of the series shown clearly an intensity and a duration of post-volcanic ozone depression observed in middle latitudes after Pinatubo eruption in 1991.

The investigations have been performed under a support of the Russian Foundation for Basic Research (grant N 99-05-64943).

C3-54

CONTRIBUTION OF URBAN AEROSOL TO ERROR OF DETERMINING ATMOSPHERIC GAS CONCENTRATION BY DIFFERENTIAL ABSORPTION METHOD

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In the report we estimate an error of determining atmospheric gas concentrations by differential absorption method, arising primarily due to spectral variations of aerosol optical properties. For this, we reviewed literature data and constructed an urban (industrial) aerosol microstructure model, analogous to the well-known WMO model and, in addition, assuming that parameters of particle size distribution functions and concentrations of different aerosol fractions can vary. Optical and remote-sensing characteristics of aerosol are calculated for the wavelength ranges 4 – 6 and 8 – 12 μm. We estimated uncertainties for two methods of determining gas concentration, namely (1) the sensing-path method, in which receiver records radiation reflected from a topographic target, and (2) location method in which the radiation backscattered by the atmosphere is recorded. For different limiting error levels the permissible spectral distances between on- and off-lines are determined; this value is required to determine optimal pairs of sensing wavelengths. It is shown that assumption of identical aerosol optical properties at the on- and off lines at times may be even larger source of error than such factors as inaccuracy of temperature data or influence of some other gases. These effects are most appreciable between 9 and 10 μm wavelengths where optical characteristics of aerosol have strong spectral variations. Different algorithms of return signal processing are presented together with associated errors in retrieved concentrations. For exemplary measurements of concentrations of water vapor, ammonia, sulfur dioxide, and other gases, we present numerical data on errors and compare them with theoretical and experimental estimates published earlier.

C3-55

MUELLER MATRIX OF HEXAGONAL ICE CRYSTALS

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Mueller matrices of hexagonal ice columns and plates are calculated by a ray-tracing method. The obtained results have revealed that there are two specific tilts both for columns and plates where Mueller matrix's elements turn into either extremums or zeros. This fact is proposed for practical applications to lidar polarization diagnostics of cirrus. To check the obtained data, a special experiment was performed where the Mueller matrix was measured for a model hexagonal column with the refractive index of 1.486. The obtained experimental data coincide with a good accuracy with the theoretical data calculated by means of the same ray-tracing program. This fact proves the correctness of the obtained Mueller matrix for the ice crystals.

C3-56

DATABANK FOR INTERPRETING RESULTS OF POLARIZATION SENSING OF ICE-CRYSTAL CLOUDS

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As is well known, orientation of ice-crystal axes relative to horizontal plane controls considerably the extinction coefficient of cirrus clouds. Current literature contains a great deal of works devoted to either theoretical, model study or analysis of results from experimental investigation of polarization state of backscattered signal recorded by lidar receiver. Most of those works are limited to just measuring or calculating the depolarization ratio $\delta = I_{\perp}/(I_{\parallel} + I_{\perp})$, not providing for a detailed information on crystal habits and orientation. Most full information on the microstructure of cirrus clouds can be available from analysis of total backscattering matrix (BSM) given some a priori model-calculated data on light-scattering properties of ice crystals.

In this report, of concern is interpretation of results of polarization laser sensing of ice-crystal clouds, with emphasis on the structure of backscattering matrix for ensemble of hexagonal ice crystals. We describe the architecture and contents of databank for interpretation of experimentally measured BSMs for ice-crystal clouds. In the report, we compare the backscattering matrices for ice-crystal clouds, obtained using Stratosfera 1M lidar, with model BSMs, calculated from the databank. The two are shown to reasonably agree.

The work, made using Lidar setup (reg. N 06–21), is supported by the Russian Fund for Fundamental Research (through the grant P98-02-03031) and Ministry of Science of the Russian Federation.

C3-57

MODEL CALCULATIONS OF SPECTRA OF THE BRIGHTNESS COEFFICIENTS FOR THE INTERPRETATION OF SPECTROMETRIC DATA ON A FRESH WATER QUALITY

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Surface water areas of the land are the objects with the optical thickness changing by a few orders of magnitude, from 0.1 to 100. Such variations can be observed at the same object during one survey. So any theoretically provided approximation is true only for the limited part (season, survey, etc.) of the object. Besides, there are no in situ measurements of the primary hydrooptical characteristics necessary for estimation of the applicability of one or another approximation. We have applied the well-known in oceanology, but incorrect (according to theoretical estimations) approximation for calculation of the brightness coefficients spectra of the radiation upwelling from water. The number of the components included into the calculation was enlarged. Dissolved organic substances and phytoplankton, including chlorophyll «a», carotinoids and phycobinins were taken into account in addition to mineral suspended substances. The OAK concentrations were varied in wide range, while the primary hydrooptical characteristics remained constant. The brightness coefficients spectra obtained by simulation have the spectral structure close to the experimental structure. The majority of the available experimental spectra obtained at different water objects in different hydrological seasons as well as in special experiments at artificial water reservoirs at polluting them by heavy metal compounds are satisfactory described in the frameworks of this approximation.

The method based on joint processing the model and experimental spectra has been developed for interpretation of the spectrometric data obtained by means of different carriers. The similarity of statistical characteristics of the experimental and model spectra arrays makes it possible to use the proposed method for general assessment of the state of water ecosystems.

C4-01

TRENDS IN THE DEVELOPMENT OF AIRBORNE LIDARS

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Recent progress and prospects for further development and application of lidars of various types used onboard aircrafts (helicopters) are considered. Much attention is being given to dual-use lidar technologies. Airborne lidars can be classed into multipurpose lidars intended for solving a wide class of problems, including purely scientific ones, and special-purpose lidars. Lidars used onboard spacecrafts including interplanetary ones can also be classified with them. At present, airborne lidars can operate in the zenith, nadir, and horizontal directions with scanning. Almost all types of lasers are used as radiation sources. Optical systems with classical refracting and reflecting telescopes, Fresnel lens, and kinoforms are used in lidars. By overall dimensions and masses, lidar change from miniature systems for pilotless aircrafts to lidars with large-sized optics for heavy aircraft-laboratories. Objects of research are rather diverse: the atmosphere with all its constituents, ozone, clouds, industrial and military aerosols, underlying surfaces from sea water to forest areas, etc. Thus, airborne lidars that allow almost all class of problems of active remote sensing to be solved and call for high technologies form a wide field of scientific research, both fundamental and applied in character.

C4-02

INVESTIGATIONS OF OPTICAL CHARACTERISTICS IN THE AIRCRAFT TRACES

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The efficiency of opto-electronics systems srtong depend from scenarios application. Nevertheless to aircfaft based opto-elecronic system is one of the most interesting scenario. The moving air-craft itself is a source of atmospheric distortions.

The aircraft trails are seriously change the atmospheric properties in the altitudes ranges 8–13 km. The emission occur near the propopause, in the upper troposhere and lower stratosphere, i.e., in the region with relatively large residence time, low temperature, low background concentrations.

There are four aerodynamic regimes of mixing of tracks with enviromental atmosphere: *(jet) stream* regime, *vortex* regime, *dispersion* (or *dissipation*) regime and long-time *diffusion* stage. During the vortex regime the contrail dynamics and evolution are defined by two counter rotating vortexes, which left the wing tips. Up to the despersion regime the turbulence inside a contrail increases by two orders as compared to the ambient atmosphere.

Preliminary experimental results for detection of optical waves fluctuations in the hot tracks behind of taking off aircraft are presented.

C4-03

PROPAGATION OF PARTLY COHERENT LASER RADIATION ON THE LONG ATMOSPHERIC PATHS UNDER THE CONDITIONS OF THERMAL NONLINEARITY

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Laser radiation propagation under the conditions of thermal self-action was studied based on the radiation transfer equation (RTE). This equation is the approximated consequence of the initial equation for the second order coherence function. The use of RTE not only depress the order of the initial equation but also carries out a transition from the complex coherence function to the real brightness function. Both these circumstances have essential importance at realization of numerical algorithms for solving the differential equations. The method of characteristics is a conventional technique to solve RTE. Use of the Gaussian approximation of the brightness function over the angular coordinate allows the problem to solve the equation in the partial derivatives to be reduced to the problem to solve the ordinary differential equation system, which supposes a creation of effective numerical algorithms.

The calculations were executed for a source and receiver located on airplane boards, the characteristic airplane velocities cross to the path were of 100 м/с. The results were obtained for the long atmospheric paths (up to 500 km) running on the height of 10-30 km. The questions of a choice of optimum values of the initial power and initial focusing of radiation were considered with the aim of the maximal concentration of radiation energy in a receiving plane.

A role of the initial divergence of radiation in a choice of the above-mentioned parameters was investigated. An influence of the atmospheric volcanic aerosol Younge layer on optimization of the radiation propagation was considered. This layer is situated at the height of approximately 20 km and causes additional nonlinear distortions of a beam due to the aerosol absorption of

radiation energy. It is shown that at the presence of the thermal nonlinear effects the optimum propagation conditions correspond to approximately doubling of the beam effective area in comparison with propagation without the nonlinear distortions.

C4-04

MONITORING OF ENVIRONMENTAL POLLUTION BY UNBURNED ROCKET PROPELLANTS

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Identification of territories polluted by unburned rocket propellants is important for prevention of possible ecological catastrophes. Hydrazin, as well as some hydrazin-bearing components of rocket propellants, has absorption bands in the spectral region 9 – 11 μm; therefore, these compounds can be detected using CO_2 laser. The present work outlines design of a helicopter open-path differential-absorption gas analyzer based on tunable mini-TEA CO_2 laser. We determined optimal energy and frequency parameters of transmitter of gas analyzer, using which it is possible to detect territories polluted by unburned rocket propellants at a range ~1 km.

C4-05

TROPOPAUSE TURBULENCE MEASUREMENTS

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Limited samples of the turbulence structure in the tropopause suggest that conventional models for atmospheric turbulence may not apply through this portion of the atmosphere. The proposed paper will discuss the instrumentation requirements, design, and calibration of a balloon borne sensor suite designed to accurately measure the distribution and spectral spatial character of the index of refraction fluctuations through the tropopause. The basis for the 15 thin wire anemometers 16 bit dynamic range, high data rate, full sample and hold instrumentation suite will be discussed. Particular attention will be paid to the calibration requirements and techniques used to characterize the frequency response of the constant current anemometers used in the measurements. Data that illustrates the noise floor, signal to noise, and response of this type of data system will be discussed. The novel technique that was developed that integrates the 15 high rate and over 10 low rate signals into two time correlated telemetry streams will be shown. The paper will include a discussion on how the data are to be processed to generate the coefficient of temperature fluctuations, C_T^2 and the scale sizes without assuming a Kolmogorov distribution. Concluding remarks will be present a schedule showing the planned flight of the balloon.

C4-06

ADAPTIVE PUMP OSCILLATOR FOR A PORTABLE CO_2 TRANSMITTER OF LIDAR SYSTEMS

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Recently, of wide scientific and industrial use (such as in movable lidar systems, medicine, and imitators of shorts and hits) have been medium-power, portable CO_2 lasers with high-quality output radiation. At the same time, high-efficiency, portable systems of HF pumping of such lasers have not yet been created. This is because the issue of matching HF oscillator with discharge laser cavity is still far from being completely resolved. The existing adaptive matching systems (1) provide no matching when the output power of HF oscillator exceeds 200–300 W, and (2) represent a separate piece of the pumping system, thus complicating substantially the system key diagram.

In the report, we explore the possibility of using an autodyne with 100 MHz pumping frequency as a HF pump oscillator. We tested the performance of autodyne with a nonlinear element (laser discharge cavity). The stability of such a pumping system is investigated. It is shown that, in case of mismatching between pumping oscillator and discharge laser cavity, the frequency mistuning does not exceed 10%; while the efficiency of the pumping system is 50% as high. Therefore, this oscillator is a promising tool for pumping of portable lasers with output power on the order 100 W.

C4-07

AIRCRAFT LIDAR FOR RESEARCH OF AEROSOL DISTRIBUTION IN ATMOSPHERIC BOUNDARY LAYER

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Much effort has been invested recently to development of remote methods of aerosol concentration measurements. Lidar is an important remote-sensing instrument, with high resolution both along sensing path and over viewing angle. As is well known, reflected laser radiation bears information on such aerosol microstructure properties as particle size distribution and concentration. Interpretation of these reflectances is very difficult and always interesting to make.

To study the aerosol size distribution in the atmospheric boundary layer, we developed a portable pulsed aircraft lidar system with the following parameters: wavelength of laser radiation is 1.06 μm, energy per pulse is 0.02 J, angular beam divergence is 1 mrad, resolution along sensing path is 10 m, minimum time interval between sensing pulses is 20 s, power consumption is 130 W (24 V), and weight is 30 kg. The reflected signals, measured by an optical sensor, were recorded by a special controller unit with fast analog-to-digital converter and static RAM. Further, all data corresponding to a given pulse were fed into a portable computer for a subsequent signal storage and processing. Aircraft sensing was made at nadir.

Using developed instrumentation we performed experiments and have found that, due to specific features of the reflected signal, the measurement accuracy depends strongly on the sensing range and signal amplitude. Practically it was determined that the limiting length of the sensing path, over which the aerosol profile was measured, was 500–800м.

The lidar measurements have revealed aerosol inhomogeneities on different horizontal spatial scales (from 100–300 m to 5–7 km) and with different vertical sizes. We identified aerosol cases that can be classified as convective columns and aerosol clouds. Survey of literature data has shown that the detected aerosol inhomogeneities, overall, have the sizes characteristic of convective cells observed in the atmosphere.

C4-08

CAPABILITIES OF AIRBORNE VIEW-ANGLE SCANNING LIDAR

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Aircraft view-angle scanning lidar offers much higher efficiency for sensing clouds and underlying surface, both because it provides wider areal coverage and since it can repeatedly sense different objects. The existing scanners (rotating optical wedges, swinging and rotating mirrors, rotating holographic diffraction gratings) constrain the lidar optical axis to move in the aircraft-fixed coordinate system along two basic trajectories: in a like manner to cone-generating line or in a cross-track plane; accordingly, during flight, in the Earth-fixed coordinate system the intersection point between lidar optical axis and a plane surface defines a cycloid or a sinusoid.

In the report, we present relations classifying trajectories by flight parameters (aircraft height and speed) and scanning parameters (scan frequency and scan angle range), as well as by angle between scanning plane and flight direction. Also given is the density of distribution of laser spots on the surface versus sensing parameters (sampling rate and laser beam divergence) and scanning parameters. We present typical scan trajectories and laser spot density distribution on surface for standard flight, scanning, and sensing parameters.

C4-09

PECULIARITIES OF LASER RANGING OF THE EARTH SURFACE FROM ONBOARD OF A SPACECRAFT

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The report provides estimates of how small variations in orientation of lidar optical axis can influence the error of determining distance to earth surface by the methods of satellite laser ranging. In the spherical earth approximation, formula is derived expressing the dependence of slant distance on possible variations of lidar optical axis orientation in the earth-fixed coordinate system, or on the error of determining the direction of lidar axis in satellite-fixed coordinate system.

The calculated results are compared with data of laser sensing of sea surface by Balkan lidar for two orientations of space station Mir.

C4-10

ANALYSIS OF POLARIZATION CHARACTERISTICS OF DIFFERENT SCANNERS FOR AIRBORNE LIDARS

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Aircraft-lidar scanners of different types (rotating optical wedges, swinging and rotating mirrors, rotating diffraction gratings) modify polarization state of optical radiative fluxes transmitted through them in a manner dependent on the angle of incidence upon active scanner component.

In the report, we present theoretical estimates of transmission coefficient of polarized radiation for reflection- and refraction-type scanners, calculated over typical ranges of incidence and reflection angles. The scanner based on the optical wedges is found to perform best of all.

C4-11

PULSED DOPPLER LIDAR MEASUREMENT OF THE WIND USING THE AUTOCORRELATION FUNCTION METHOD

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In the papers [1] the theoretical analysis of the effect atmospheric turbulence on the accuracy of the wind measurement is considered. The results of the analysis describe exactly the cw-Doppler lidar performance within the limits of the used models. In the case of the pulse Doppler lidar this analysis is an approximate approach. It is assumed that the condition is fulfilled when the spectral width of the laser is less or comparable with the turbulent spectral width of the Doppler lidar signal. However, this condition cannot be fulfilled. The goal of this paper is the development of a theoretical approach to the analysis of the average and true wind velocity measurements obtained from the frequency estimation of the non-Gaussian pulsed Doppler lidar signal with the arbitrary spectral width. The approach, which is proposed in the paper, takes into account the frequency jitter effect of the laser.

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C4-12

USINGE OF THE DF LASER IN BOARD - BASED LIDAR FOR DETECTION OF AEROSOL AND GAS LEAKAGES

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In connection with intensive development of oil, gas and chemical complex the large importance is got by a task of the control of aerosol and gas emissions, representing by itself a source of the increased ecological danger. Therefore there is a problem of development of the appropriate methods of researches of local gas structure of an atmosphere. For the decision of these tasks perspective is application of board - based lidars with use as source of radiation of the DF laser, which now is let out by an industry in air execution. In the report the estimations of opportunities of DF lidar for the control of aerosol and gas structure of an atmosphere are resulted and also the technical requirements of lidar board - based system are formulated.

C4-13

MODELLING CRITERIA SELECTION DURING ELABORATION OF LIDAR COMPLEX GAS DISCHARGE LASERS PUMPING SYSTEMS

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Gas-discharge lasers have been widely used, in particular, in atmospheric sensing applications. In the present work, it is shown that the algorithm of selection of simulation criteria, consisting essentially of identification of most general features of study objects, may lead one to such techniques as methods of dimensional theory and similarity theory. In the report, we present

similarity relations for electrodeless gas discharges; they are obtained using this algorithm and allow one, on the basis of model results and numerical calculations, to develop actual pumping devices for gas discharge lasers. The similarity relations are defined with account of the following factors: 1) Capacity of dielectric walls of discharge cavity. 2) Molecule ionization by electron strike. 3) Electron adhesion to (and detachment from) negative molecules (which is important for working mixtures of CO_2 and CO lasers). 4) Electron diffusion to the walls of the discharge cavity. 5) Influence of near-electrode layers of the spatial charge. 6) Processes on dielectric surface (or electrode surface when no dielectric is present): emission due to striking positive ions, as well as photo emission due to optical radiation of discharge (with account of absorption by plasma). 7) Influence of electrons of discharge on conductivity and dielectric constant of plasma. 8) Influence of parameters of external discharge circuit.

It is shown that, in the general case of inhomogeneous electric fields, similar electrodeless discharges take place in geometrically similar discharge cavities for a constant product of gas pressure times the width of discharge gap. For such discharges, as cavity sizes and gas pressure change, the quantities remaining invariant are: the ratio of the density of electrons, formed in the discharge, and density of currents, flowing in different cavity sections, to the square of gas pressure; product of the characteristic time constants of processes, flowing in discharge, times the gas pressure; efficiency of the system of pre-ionization by electrodeless pulsed discharge, determined by the product of the ionization potential of the working gas times the ratio of density of electrons, formed in the discharge, to the pre-ionizer energy per unit gas volume. Also given are the similarity relations for the electrodeless gas discharges. In which homogeneous electric fields exist.

The similarity relations are used to develop the methods of designing of pumping systems for gas discharge lasers. Presented is the method of designing of pumping system for CO_2 lasers with non-self-maintained discharge and pre-ionization of active medium by electrodeless pulsed discharge.

D1-01

THE INFLUENCE OF ENTERING SUBSTANCE ON THE OPTICAL PROPERTIES OF HIGHER ATMOSPHERE

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There are entering to higher atmosphere of Earth species

1) high energy space and solar particles (electrons, protons, α-particles, atomic ions)
2) meteor substance
3) precipitating from neighboring space technogenic material (splinters of missiles and space apparates, dust particles, radioactive products, organic molecules).

The high energy particles are responsible for the gas molecule ionization and the following generation of new gas and aerosol products everywhere in the atmosphere down to troposphere. The estimations of some of this effects in atmosphere processes are presented. The role of meteor substance has been investigated early rather thoroughly.

The influence of technogenic origin materials precipitated from neighboring space to the earth atmosphere on the processes and properties of atmosphere up to now was considered as negligible. Nevertheless the accumulation of this material at the neighboring space in almost fifty years due to the space investigation has resulted in the technogenic origin solid particles flux to atmosphere became comparable with the meteor ones, and taking into consideration the specific properties of this particles their influence on the properties and processes of higher atmosphere confirms to be more essential than the meteor dust.

D1-02

DEVELOPMENT OF CRYSTAL FORMATIONS IN THE UPPER TROPOSPHERE ASSOCIATED WITH THE SOLAR PROTON BURSTS

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There is on doubt now on the cosmic ray variation influence on the process of forming ensambles of optically active particles in the lower atmosphere. The following mechanism of the influence of high-energy particles on the condensation processes in the atmosphere is proposed:

1) charging gas molecular with cluster formation,
2) charging primary aerosol particles,
3) the change of the atmosphere gas composition

With the increase of the aerosol forming components. The second mechanism is analyzed. The lowering of the condensation threshold for small size particles moves to be of a low efficiency. More effective is the effect of a different charge of polydispersive aerosol particles of various chemical composition. The coagulation rate in such a aerodispersive system may some times exceed that in a system without charged aerosol particles.

However realization of that process demands a special initial state of the aerodispersive system. At the same time, the real time (of about 3 days) of the optical thickness of aerosol layer reasonably agrees with the model calculations of the coagulation growth of the aerosol layer. Even more real is the influence of charged particles on the predominatingly crystal growth of the aerosol substance. Existance of a unit charge at aerosol particle surface results in the increase of the crystallization temerature by 20° (V.V. Klingo). It is obvious that partically all the charged particles in the case of the water vapour existance at heights more then 5 km will be covered by ice shell. The scattering of the solar radiation at those particles will significantly increase.

There are carried out calculation of optical characteristics of aerodisperse ensambles with ice shells as well as comparison of them with available experimental data.

D1-03

VARIATION OF SUSPENDED PARTICULATE CONCENTRATION IN THE MOUNTAINOUS COASTAL CITY

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A three-dimensional non-hydrostatic model in a complex terrain-following coordinate (x, y, z^*) and a random walk model (x, y, z+) for tracing lagrangian motion of particulates were adopted for a 48 hour numerical experiment from 0900LST, August 13 to 0900 LST, August 15, 1995, by using HITACHI supercomputer. Two different domains consist of 50×50 grid points with each 20km interval and 5km in coarse and fine-mesh models for one-way double nesting, and 15 levels upto 6km height. Convective

boundary layer is developed at the level of 1km over the ground of the mountain, while thermal internal boundary layer below an easterly sea breeze circulation with a return flow at 1700 m height toward the East Sea. is only confined to about 100 m height along the eastern slope of the mountain. The floating particulates were dispersive eastward below the height of sea-breeze circulation and then, widely spread out over the coastal sea. As a shallow nocturnal surface inversion layer, after sunset, was produced and westerly intensified downslope wind with mountain-land breeze could penerate into a city, the floated particulate matters during the day also moved down along the eastern slope of the mountain and then passed through the city, showing their maximum ground level concentrations at 3-00 LST.

D1-04

PECULIARITIES OF TEMPORAL BEHAVIOR OF THE FINE AEROSOL AND SOOT CONTENTS IN THE NEAR-GROUND AIR LAYER

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Regular round–the–clock measurements of the scattering coefficient of the dry matter of aerosol particles and the mass concentration of soot were carried out in 1997–1999 at the aerosol station situated at the west outskirts of the city of Tomsk.

This paper presents the results of the analysis of variations of the mass concentrations of dry aerosol, soot and the relative content of soot in aerosol particles on different temporal scales: year, season, month, 10 and 5 days, day and hour. The minimum values of aerosol content of three year were observed in 1998. Seasonal variability is characterized by the tendency of decreasing the volume of aerosol and soot and the relative content of soot at passing from cold season to the warm one. Let us note that the total limits of variation of the separate readings were $M_a = 3 - 270$ μg/m^3 and $M_s = 0.1 - 25$ μg/m^3. If take into account the events of burns and forest fires, one can see that smoke aerosols make a significant contribution. For example, taking into account the smokes in spring 1999 caused the increase of the seasonal mean aerosol concentration by 1.7 times and the increase of soot by 1.4 times. Annual mean values increases because of the fires by 1.3 and 1.1 times, respectively. But there was no significant increase of the relative content of soot. The most strong effect of forest fires was observed in fall 1997 when the dense smoke haze was observed during a week. Actually one can ignore the effect of forest fires only in 1998.

Analysis of the contribution of different temporal scales into the variance of hourly data has shown that daily variations of both aerosol and soot can amount to 20 to 50% of the total variance with the tendency of increasing to summer. The exception is winter 1997 when the contribution of daily variations of aerosol with greatest of the year and was about 50% of the variance. Synoptic-scale variations can determine 40 to 75 % of the total variance with the tendency of increasing to spring and summer.

The work was supported in part by Russian Foundation for Basic Researches (grant N 00-05-65204).

D1-05

RESALTS OF STUDY THE SUBMICRON AEROSOL ABSORPTION OF IR RADIATION

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The attempt is undertaken in this paper to quantitatively estimate the contribution of submicron aerosol into the extinction of IR radiation on the basis of measurements of spectral transmission of the atmosphere in visible and IR spectral ranges on horizontal paths.

To solve this problem we used the statistically provided bulks of spectral aerosol extinction coefficients obtained in hazes in different geographical regions in different seasons and at the wide range of variations of meteorological parameters. The component related to submicron aerosol was selected by statistical method developed by authors based on the multiple regression analysis.

The quantitative estimates of the extinction coefficients of IR radiation of the fine fraction of aerosol particles are obtained as functions of the air turbidity in the visible wavelength range and of the relative humidity variations. The calculations are performed for two geographical regions: Black Sea coast and South of Western Siberia. The experimental data are compared with the results of numerical simulation of the aerosol optical properties. It is shown that the contribution of submicron aerosol into the extinction of IR radiation is approximately 0.01–0.03 1/km that is one order of magnitude less than the portion of coarse aerosol, the extinction by which is comparable with the contribution of the continuum absorption of water vapor in summer.

D1-06

SPECTRAL LIDAR INTEGRATING NEPHELOMETER FOR ATMOSPHERIC IN SITU INVESTIGATIONS OF THE SCATTERING COEFFICIENT

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The results of preliminary tests of an automatic integrating nephelometer intended for recording of molecular and aerosol scattering coefficients are presented. The limits of angular integration of the nephelometer were from 5° to 175°. The diffraction grid was used as a dispersive element. The frequency range of recording of molecular and aerosol scattering coefficients was from 300 to 820 nm.

The nephelometer is a two-channel device to simultaneously record scattering coefficients on two wavelengths, which were 30 nm apart. This allows to estimate an index of a power in the Angstrom law with high accuracy whose value shows the ration between aerosol and molecular scattering.

The variation of an upper limit of integration in the nephelometer is provided for determination by subtraction of the backscattering coefficient. It is known that a relation of backscattering to coefficient of total scattering determines a "lidar relation", which can be used for a calibration of one-frequency aerosol lidars.

It is presumed that the device for *in situ* observations will be used at long-time observations of the scattering coefficient. High frequency of data recording permits us to use the nephelometer for estimation of turbulent aerosol flows, if will carried out measurement of components of a wind velocity synchronously with use of the nephelometer.

D1-07

TRANSFORMATION OF AEROSOL DISPERSED COMPOSITION FROM BACKGROUND TO THE CONVENTIONAL STATE BASED ON THE MEASUREMENTS OF AEROSOL OPTICAL THICKNESS (AOT). P. 1. COARSE FRACTION

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This paper discusses the problem of anomalous atmospheric transmittance due to the peculiarities of aerosol dispersed composition under conditions(or at invasions) of pure arctic air based on the microphysical modeling and the solution of inverse problem. The independence of existence and different stratification in the atmosphere of various aerosol fractions determines the necessity of their individual consideration. The situation of anomalous spectral dependence of AOT, with a minimum about 0.44 mm and a broad peak in the 0.6–0.8 mm range, makes it possible to separate the contribution of coarse (P. 1) and secondary (P. 2) aerosols and to analyze the aerosol development individually.

The reconstructed particle size distribution in the range of primary aerosol dimensions has its specific characteristics, namely, a relatively small content of coarse fraction ($r > 1$ mm) at a narrow and stable (no more than three days) mode in the 0.5–0.6 mm range. When analyzing this problem we concluded that the existence of this fraction agree with the results of some microphysical measurements in different atmospheric layers and the assessments of the effect of monodispersity of coarse aerosol under the action of Stoces deposition in the stratosphere. That is, a narrow mean-dispersed fraction is a results of an effective gravitation sink and it can be considered as end stage of primary aerosol as its generation stopped.

In the results of optical measurements (AOT) due to the integrated contribution to the different size particle scattering, the manifestation of the narrow fraction is veiled and under normal conditions is not detected. Under background conditions, with decreasing the content of secondary and coarse aerosol, the mean-dispersed mode becomes decisive in the spectral dependence of AOT. The considered grounds are supported by the results of the optical data inversion obtained under pure air conditions: long-term data obtained in the Antarctic, the mountain measurements, the anomalous spectral transmission in Tomsk. The work has been supported by the Russian Foundation for Basic Research (Grants 98-05-03177-a; 00-03-32422-a)

D1-08

TRANSFORMATION OF AEROSOL DISPERSED COMPOSITION FROM BACKGROUND TO THE CONVENTIONAL STATE BASED ON THE MEASUREMENTS OF AEROSOL OPTICAL THICKNESS (AOT). 1. COARSE FRACTION. 2. SECONDARY AEROSOL

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The dynamics of the development of secondary aerosols has been studied on the basis of model estimates as a possible mechanism of relaxation of the spectral dependence tA(l) from the situation of anomalous transparency to the ordinary one. The

estimates have been obtained based on the system of equations determining the dynamics of the integral characteristics of the fine fraction formed from the particles of nanometer size resulting from the coagulation growth.

The calculations have shown that one can select three stages in the development of microdisperse aerosols. Quantitative accumulation of nanometer aerosols occurs at the first stage. Their size spectrum is analogous to the spectrum of the source of generation su(r). As some level of number density N1(t1) is reached, the coagulation of particles activates. The size spectrum changes its shape, the modal radius reaches the value rm1. At the second stage at the mean power of the source the final spectrum can gain the tendency of narrowing. However, the number density continues to increase with less rate, and narrowing of the size spectrum stops as some quasistationary level is reached. Then the second stage is finished.

At the third stage, if the source power has been quite high due to the high efficiency of the coagulation of particles, s(r) continues to displace, and narrowing the spectrum is replaced with the tendency of widening. Starting from some t = t2 the microdisperse fraction reaches the size range of the accumulative fraction. Its optical significance increases on the background of the low content of accumulative fraction, and tA(l) is transformed to the ordinary spectral dependence.

The values of the parameters N1, N2, t1, t2, and rm1 depend on the efficiency of coagulation of particles as well as on the specific peculiarities of the source of generation su(r).

The results obtained are in good agreement with the rate of change of tA(l) and make clear the reason of its constancy during two first days.

The work was supported by Russian Foundation for Basic Researches (grants N 98-05-03177-a and 00-03-32422-a).

D1-09

THE DETERMINATION OF ATMOSPHERIC GASES AND AEROSOL PARAMETERS BASED ON AIRBORNE MEASUREMENTS OF SPECTRAL FLUXES

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The measurements of downward and upward spectral fluxes of solar radiation were carried out in 80-th on IL-14 aircraft. In present time, based on modern computers, reprocessing of this data were done not for only determination of net fluxes, but for atmospheric aerosol parameters vertical profiles determination. Based on calculation of fluxes (numerical simulation), hight sensitivity of measered values to variation gases and aerosols components of the atmosphere and, accordingly, probability of retrieval vertical profiles of concentration vater wapour, ozone and also profiles and spectral dependence aerosol scattering and absorption volumic coefficients was showed. The a priori models of low atmosphere for two regions of measurements: Ladoga Lake and Kara-Kum desert were developed. The inverse problem for retrival spectral dependences and vertical profiles of aerosol volumic scattering and absorption coefficients and water wapour and ozone concentration was solved and errors of this retrival were analased.

D1-10

ESTIMATION OF EXTINCTION, SCATTERING AND ABSORPTION CROSS SECTIONS OF ISOTROPIC POLYDISPERSIONS OF SPHERICAL PARTICLES

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Quadrature formulas of the Gauss type are constructed for estimating the extinction, scattering and absorption cross sections of spherical particles with accuracy up to $(2n - 1)$ momentum of the distribution inclusively, n is the number of nodes. The construction is based on the theory of orthogonal polynomials with the weight equal to the distribution density function. Physical interpretation of the quadrature formulas is considered. Efficiency of the formulas lies in the use of the data on microstructure (momentum of the distribution) of the polydispersion. The results are generalized for the case of polydisperse spheroids. The results are compared with the results of calculations by the exact theory using the T-matrix method.

D1-11

SOLUTION OF THE INVERSE LIGHT-SCATTERING PROBLEM FOR SUSPENSION OF BIOLOGICAL PARTICLES ON THE BASE OF THE SCANNING FLOW CITOMETRY

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In order to analyse suspensions of biological particles such as micro-organisms, detritus and others optical methods are widely used. One of the contemporary method of the determination of the size parameter and relative refraction index of spherical biological particles is flow indicatrix method, which based on the scanning flow citometer.

This method allow to determine the size and refractive index of spherical biological particles with follow indicatrix parameters: indicatrix fringe pitch and indicatrix visibility [1]. Along with other optical methods the exact Mie solution is base of the flow indicatrix method.

We propose the approximations for the receiving of simple analytical expressions for size parameter and relative refraction index of spherical biological particles, which can correct regions of flow indicatrix method work. The most general and simple solution of the light-scattering problem for optically soft particles (refractive index m of particles is close to 1) can be produced on the basis of the integral wave equation in the Wentzel-Kramers-Brillouin (WKB) approximation. Furthermore, the light-scattering approximations: Rayleigh's scattering, Rayleigh-Gans-Debye approximation (RGD), anomalous diffraction (AD), and Fraunhofer diffraction (FD) result from the WKB approximation in regions where these approximations can be correctly applied [2].

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D1-12

ANNUAL BEHAVIOR OF AEROSOL CONDENSATION ACTIVITY IN THE NEAR-GROUND LAYER OF THE ATMOSPHERE

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Relative humidity of air determines and intensifies the cycles of variability of the optical state of the atmosphere, because it is caused by the characteristic values of temperature and water vapor content in different air masses and has the well pronounced diurnal behavior. Therefore, the study of condensation activity of atmospheric particles is one of the basic problems in improvement of the models of the aerosol optical characteristics. To solve this problem, we apply the approach of separate experimental study of variations of the dry matter of aerosol particles and their condensation activity.

The nephelometric setup equipped with systems for artificial moistening and heating of aerosol was used. The dynamics of the aerosol scattering coefficient under the effect of relative humidity was approximated by the Kasten – Hanel formula $\sigma = \sigma_0(1-r)^{-\gamma}$, where σ is the scattering coefficient, σ_0 is the scattering coefficient at zero relative humidity, r is relative humidity and γ is the parameter of condensation activity.

The characteristic peculiarities of annual behavior of the parameter of condensation activity observed in 1998 and 1999 are close to each other. Two maximums are well pronounced (in spring and fall). The decrease of the parameter of aerosol condensation activity occurs since spring till July, then its increase is observed since August till the middle of October, the approximately constant value γ is observed since the middle of December. The aerosol condensation activity sharply increases since the beginning of March and reaches its maximum value approximately at the beginning of middle of April.

Possibility of parametrization of the annual behavior of aerosol condensation activity is also considered in the paper.

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D1-13

EXTENSION OF MEASUREMENT PARAMETERS OF PHOTOELECTRIC COUNTERS IN COLOR BANDS

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Interference photoelectric counters (PEC) of particles are capable of excluding the error caused by the refractive index of particle that is characteristic of usual PEC with amplitude registration. It is caused by the principle of measurement based on measuring the depth of modulation of the light flux at different wavelengths.

In this paper we analyze the possibilities of obtaining the data of refractive index, shape and structure of aerosol particles by means of interferometric PEC on the basis of measuring the intensity of the scattered light at different wavelengths. It has been shown by electrodynamoc calculations for particles of different shape and structure that the accuracy of measuring the refractive index can be increased due to measuring the total intensity of light at big aperture angles. Measurements at small aperture angles provide maximum information on the particle shape.

The issues of realization of optical and electronic blocks of PES operating in color bands are considered.

D1-14

LIGHT SCATTERING INTO SOLID ANGLES. APPLICATION TO PHOTOMETERS WITH VARIED GEOMETRY OF INCIDENT LIGHT

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This paper considers the lightscattering in arbitrary cone solid angles by an isotropic ensemble of spheroids. Analytical expressions for the scattered fluxes in arbitrary cone angles are obtained for the non-coherent incident light with different geometry using the expansion of the scattering phase matrix elements in terms of Wigner functions. The results obtained are applied to calculation of photometers with varied geometry in order to obtain the data on the mean size and refractive index of particles.

D1-15

NUCLEATION RATE IN VAPOR-GAS MIXTURE WITH VAPOR SOURCE AT BOUNDARY ON EXAMPLE OF STATIC DIFFUSION CHAMBER

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Experimental study of the kinetics of supersaturated vapor homogeneous nucleation is based on determining the dependence of the nucleation rate of the vapor supersaturation at other parameters kept constant. The static diffusion chamber capable of direct measuring the nucleation rate is the powerful instrument for the study of the vapor nucleation. The vapor supersaturation was calculated based on the model of heat and mass exchange in cylindrical layer between two plane plates with different temperature. The principal difficulty of the model is prescribing the vapor radial flux to the chamber sides [1] if assume that the diffuse flux at the vapor-liquid boundary is equal to zero. The static diffusion chamber is the open system, because the constant (stationary) motion of the vapor from one boundary to another occurs. By virtue of this fact the model with zero flux on the vapor-liquid boundary is not correct.

This paper presents the system of equations describing the heat and mass exchange taking into account the vapor flux at the vapor-liquid boundary and its analytical solution for the one-dimensional case. The vapor flux was determined from the condition of impenetrable boundary for gas. The calculated supersaturation values were compared with the data on example of the n-pentanol nucleation rate [2]. It is shown that calculation of the supersaturation at the prescribed values of the nucleation rate taking into account the vapor source at the boundary provides the significantly less values than without taking it into account.

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D1-16

COMPLEX LABORATORY STUDIES OF THE MARINE AEROSOLS

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Dielectrics (compounds with the wide prohibited zone) can make their contribution into the heterogeneous processes both in the troposphere and in the stratosphere. The particles of halogenides of alkaline metals produced abundantly over the ocean surface are related to such compounds. The halogenides of alkaline metals are known as photocatalysts initiating various reactions. The basic absorption bands of such compounds are in the range $\lambda < 259$ nm. The alkaline-halogen crystals can contain the painting centers formed by admixtures or generated by hard radiation. It provides their catalytic and adsorbing activity at the wavelengths up to 800 nm.

Interaction of alkaline-halogen salt microcrystals with atmospheric air in the high-energy fields seems to be of special importance. Direct chemical reactions initiated by «hard» ultraviolet part of solar radiation in the stratosphere are important for the atmospheric chemistry. At the same time, the stratosphere has natural and anthropogenic radioactivity.

This paper presents the estimate of the possible effect of heterogeneous reactions with participation of marine aerosol affecting by plasma, x-rays and UV radiation on the chemical processes in the atmosphere.

Complex laboratory investigations have been carried out of alkaline-halogen microcrystals by the methods of electronic microscopy, x-ray structural analysis, ultraviolet and infrared spectroscopy. It is shown that the reactions of hydration, oxidation and nitration of microcrystals into salts intensively occur under the noted conditions. The radiation-initiated heterogeneous processes cause formation and crystallization of new compounds (nitrates, oxihalogenides), enrichment of the surface with the compounds of $ClNO_2$ type and accumulation of the U-centers. It is accompanied by significant variations of the optical characteristics of particles in ultraviolet and infrared spectral ranges.

D1-17

ABOUT BIMODAL AEROSOL SIZE DISTRIBUTION

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The paper presents the results of investigation of homogeneous nucleation in the carrier gas (nitrogen) - supersaturated glycerin vapor medium in the vicinity of triple point.

The dependencies of the number density and size of the formed aerosol particles were studied experimentally as functions of saturation temperature of the substance under study (glycerin) at different pressure in the system, different temperature of the laminator and temperature of the condensing chamber wall. The size of the particles formed in the nucleating particles and their number density were measured by the laser spectral analyzer at the inlet of the laminar diffusion chamber.

The revealed bimodal distribution of glycerin aerosol particles in the vicinity of the triple point experimentally confirms the result predicted by M.P. Anisimov [1] on the existence of two nucleation rate surfaces in the condensed phase near the phase transition of the first type.

From the standpoint of the topological analysis, two nucleation rate surfaces of crystal and liquid nuclei are essentially different, and they grow with different rate because molecules have different probability of condensation on the different phase nuclei (crystal and liquid). As result, the bimodal particle size distribution appears. Thus, two nucleation rate surfaces are experimentally revealed.

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D1-18

THERMOMICROSTRUCTURAL ANALYSIS OF THE SUBMICRON AEROSOL

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Thermooptical investigations have shown that the atmospheric aerosol particles contain substances of different volatility and are characterized by variety of chemical composition. The thermomicrostructural method is the most perspective. It lies in measuring the particle size distribution function as function of temperature.

To determine the quantity of substance of certain volatility in the aerosol particles it is necessary to reconstruct the dependence of the particle volume V(T) on temperature from the data on $g(d, T)$. This problem can be easily solved in the approximation of homogeneous aerosol.

In the case of inverse-power particle size distribution, one can determine the dependence of particle size and volume on temperature from the data on the ratio of number densities.

In the case of one-mode or one-top distribution when the maximum of the number density is in the particle size range we study, it is enough to follow the dependence of the modal radius of particles on air temperature.

One can illustrate the technique for determining the portion of volatile species on example of thermomicrostructural measurements of aerosol in summer 1999 in the "Poima-99" experiment. Particle size distribution function was measured in the particle size range from 0.3 to 1.0 μm by means of the AZ-6 photoelectric counter of aerosol particles. Controlled heating of the analyzed air flux made it possible to record the microstructural thermograms in the temperature range from 20 to 300 °C. The analysis of the results of measurements of the particle size distribution function has shown that one can divide all observed size distribution functions into three types on the basis of the behavior of $g(d)$ near $d = 0.3$ μm.

The work was supported by MNTC (grant N 1235)

D1-19

ON THE EFFECT OF OPTICAL CHARACTERISTICS OF THE ATMOSPHERE ON THE DEPENDENCE OF THE CLOUDLESS HORIZON BRIGHTNESS ON THE AZIMUTH

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Interest to the observed optical horizon range is caused by application of some methods of passive sounding and requirements of radar problems (horizon background). The results obtained of theoretical and experimental investigations of the cloudless horizon (~0–3°) brightness are not finished yet as simple models connecting optical characteristics of the atmosphere and radiation parameters measured at the ground surface. The purpose of this paper is to study the peculiarities of formation of the dependence of the sky brightness on the azimuth in the visible wavelength range based on the statistical simulation algorithms.

In general case solution of the radiation transfer equation at the angles near the horizon needs to take into account sphericity of the atmosphere. It has been shown based on the numerical estimates that the problem can be solved in first approximation in the frameworks of the plane-parallel atmosphere. As aerosol makes the principal contribution to he formation of spatial structure of the brightness field, at this stage we did not take into account molecular scattering and absorption.

The effect of the aerosol optical characteristics such as optical thickness, single scattering albedo and scattering phase function on the sky brightness field near the horizon at different zenith angles of the Sun is discussed on the basis of model calculations. The brightness distribution on the azimuth is analyzed taking into account separate contribution of single and multiple scattering of light.

D1-20

LONG-TERM OBSERVATIONS OF THE ATMOSPHERIC AEROSOL CHEMICAL COMPOSITION AT THE SOUTH OF WEST SIBERIA IN SECOND HALF OF 90th

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This paper continues the series of papers devoted to the study of the chemical composition of atmospheric aerosol over West Siberia. The ion and element composition of atmospheric aerosol in the layer from 500 m up to 7 km is considered. The baseline for analysis is the aerosol samples collected onboard the "Optic-EM" aircraft-laboratory over forest area situated on the right coast of river Ob' 70 km to the south of the city of Novosibirsk or over wetland and forest near village Plotnikovo, Tomsk region. Flights were performed every month since summer 1997. 25 flights were carried out since July 1997 till August 1999 at clear weather. Aerosol samples were collected on the AFA-Vp-20 filters at 8 heights in each flight. The wind direction was taken into account so that the plumes of cities were out of the area of aerosol sampling.

Temporal distributions of the concentrations of ions and elements included into aerosol particles at different heights and the vertical profiles of the elements were constructed from the data of chemical analysis of the collected samples. It was confirmed again [1] that December is characterized by the increase of the mineral aerosol component (Fig.) generated principally by dispersion (Al, Ca, Mg, Si, Cu). High concentrations in September and October 1998 can be explained by forest fires occurring on big area.

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D1-21

SPECTRAL MODIFICATION BEER'S LAW AND RELATION FROM HUMIDITY ATTENUATION COEFFICIENT IN THE ATMOSPHERIC SEABOARD HAZE

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Spectral form of the Beer law has been proposed based on the theory of similarity for the aerosol extinction coefficient of marine haze in the atmospheric "transparency window" $0.48 \cdot 10^{-4}$ cm < λ < $0.76 \cdot 10^{-4}$ cm. Depending on relative humidity, marine haze was considered as either a monodisperse ensemble of droplets of the water solution of sea salt or the homogeneous totality of solution droplets including the solid soluble core. Spectral form of the Beer law has been compared with the empiric data on the dependence of the aerosol extinction coefficient on the wavelength at fixed values of relative humidity. The dependence of the spectral form of the Beer law at fixed wavelength λ = $0.48 \cdot 10^{-4}$ cm on relative humidity has been compared with the available laboratory observations of the change of the Itken particle radius in the moist atmosphere as well as with the field data on the aerosol extinction coefficient. It is revealed that the aerosol extinction coefficient is determined not so much by big soluble cores rather than by Itken particles. It is shown in the frameworks of the proposed thermodynamic model of marine haze that the dependence of the aerosol extinction coefficient on humidity is ambiguous because it consists of two branches which form the hysteresis loop.

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D1-22

ON THE ESTIMATE OF SINGLE SCATTERING ALBEDO OF FINE AEROSOL FROM THE DATA ON THE SCATTERING COEFFICIENT AND SOOT CONCENTRATION

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This paper presents the results of approximate estimation of the single scattering albedo of fine aerosol on the basis of the data obtained in simultaneous measurements of the direct scattering coefficient of the dry matter of aerosol particles at the wavelength of 0.52 μm and the mass concentration of soot. Measurements were carried out in the ground layer of the atmosphere and from onboard the AN-30 "Optic-E" aircraft-laboratory in 1997–1999. Calculation were performed assuming that the absorbing substance (soot) is contained in aerosol composition as an external admixture. The cross section value 10 m^2/g was used for calculation of the absorption coefficient from the data of the mass concentration of soot. According to the literature data, this value is acceptable as a mean estimate for many real atmospheric situations and is in agreement with calculations for the fine soot particles of different disperse composition. The cross-section value in the Rayleigh particle approximation was also considered. The single scattering albedo was estimated for different seasons taking into account the principal peculiarities of the seasonal variations of the relative content of soot and the condensation activity of aerosol particles. For example, it follows from the data obtained that the albedo values at relative humidity of 75% increase when passing from winter to summer and vary in the limits 0.90 to 0.98. Let us note that the tendencies of decreasing the condensation activity of aerosol particles and the relative content of soot at approaching to the warm season competitively affect the albedo and favor its less variability.

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D1-23

THE STUDY OF THE REDUNDANT ABSORPTION OF VISIBLE RADIATION IN LABORATORY CONDITIONS

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This paper presents the results of investigation of the residual extinction in visible wavelength range as function of absolute humidity of air on the basis of experimental data obtained in the multipath laboratory chamber [1]. Let us remind that [1] has presented the results of measuring the absorption of radiation of Ar (λ = 0.44 μm), He-Ne (λ = 0.63 μm) and CO_2 (λ = 10.59 μm)

lasers by water vapor on the 2.98 km long path at different values of temperature and humidity. The increase of the extinction coefficients in the visible wavelength range as humidity increases is observed in the laboratory chamber like in field conditions. The dependencies of the redundant absorption on absolute humidity are obtained by the «minimum points» method.

The results of investigation of the redundant absorption in the visible wavelength range and continuous absorption in the range 10.6 μm obtained from the laboratory data are compared with the data of field measurements. The satisfactory agreement of the results of investigation of the redundant absorption in the laboratory chamber and field conditions is observed [2]. It follows from the comparison of the results of investigation of the continuous absorption that the sum of the redundant and continuous absorption coefficients obtained in the field conditions is close to the continuous absorption value obtained in the laboratory chamber.

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D1-24

ON THE SPECTRAL DEPENDENCE OF THE REDUNDANT ABSORPTION OF OPTICAL RADIATION IN THE WAVELENGTH RANGE 0.4 – 12 μm

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This paper presents the results of investigation of the residual extinction in the wavelength range 0.44-11.5 μm as function of absolute humidity of air. Contrary to [1], where the extinction by submicron fraction of aerosol particles was excluded from the total extinction, besides the continuum absorption by water vapor and selective absorption by atmospheric gases. The residual absorption obtained in such a way is the sum of aerosol extinction by coarse fraction of aerosol particles and continuous redundant absorption. The dependencies of the redundant absorption on absolute humidity are obtained from the minimum points in the frameworks of linear and square dependencies, where α_{red} is the redundant absorption coefficient, k_{a1} and k_{a2} are the absorption coefficients, a is absolute humidity. It is shown that, contrary to [1, 2], where the absorption coefficient decreases as the wavelength increases in the visible range, here it has the neutral behavior in visible and near IR wavelength range and increases in the longwave range.

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D1-25

THEORETICAL INVESTIGATION OF SPEQULAR REFLECTION FROM ORIENTED PLATES AS APPLIED TO BISTATICAL SENSING

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Big potential in the study of upper and middle atmosphere can be realized at the remote sensing by means of the bistatic polarization scanning lidar. The mirror reflection of optical radiation from an oriented semitransparent plate is studied in this paper. The relationships for polarization characteristics and scattering cross sections are obtained in the frameworks of the physical optics method as some combinations of the scattering phase matrix elements. The expressions obtained make it possible to carry out theoretical study of this parameters as functions of the particle size, refractive index, orientation relatively to the source and detector both for polarized and unpolarized incident radiation. The principal peculiarities of the reflection are illustrated that allow to select the informative directions of investigation for interpretation of the data of sounding. It is revealed based on the numerical study that there is the well pronounced proportional dependence of the cross section on the crystal size and the wavelength. The regular dependence of polarization characteristics on the orientation and refractive index of particle is revealed. The unpolarized radiation partially polarizes at the reflection. The degree of polarization mainly depends on the position of particle relatively to the source. It is known that such optical phenomenon as solar columns is caused by interaction of solar radiation with horizontally oriented plates. The model proposed can be used for the study of this effect. When modelling the mirror reflection, there is a

possibility to simplify the interpretation procedure for the data of bistatic sounding, because there is no dependence of scattering on some angular characteristics. The possibility of estimating the microphysical properties of crystal aerosol from the data of bistatic polarization laser sounding is shown in this paper.

D1-26

STATISTICAL COMPARISON OF EXPERIMENTAL DATA AND MODEL ESTIMATES OF THE AEROSOL EXTINCTION

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In this paper we analyze the results of simulation and the experimental data on the spectral aerosol extinction coefficient on horizontal near-ground paths. The following statistical parameters of corresponding ensembles of theoretical and experimental data are compared: the mean values of the coefficients b(lk), their rms errors sb(lk), as well as the expansions in terms of the orthonormalized system of eigenvectors ji(lk) of the autocorrelation matrix Bbb(lk,li). The data were obtained in Crimea in 1981, in Tomsk in 1995. Particular situation of intensive forest fires in Siberian region was observed in fall 1997. Mutual analysis of the data obtained made it possible to assess the role of regular and random factors of atmospheric variability of the spectral transparency. In particular, some specific peculiarities of formation of the disperse structure of the near-ground haze characteristics of the aforementioned periods of measurement are revealed on the basis of comparison of the results of simulation with experimental data.

The data on the size spectrum cover practically all active range of the size of particles of near-ground haze and are in good agreement with the data of direct microphysical measurements in separate size ranges.

The work was supported by Russian Foundation for Basic Researches (grants N 98-05-03177-a and 00-03-32422-a).

D1-27

VARIATIONS OF MICROPHYSICAL PARAMETERS OF ATMOSPHERIC AEROSOL ON SPECTROPOLARIMETRICAL INVESTIGATIONS

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The paper presents the results of atmospheric aerosol investigations performed by means of a spectropolarimeter. Measurements were carried out at Zvenigorod Scientific Station of Institute of Atmospheric Physics since November 1999 till February 2000 in daylight time and evening.

The spectropolarimeter recorded the polarization components of the scattering phase function at the angles of 45, 90 and 135° in the wavelength range 0.4 to 0.75 μm. The device was equipped with low–temperarute heater of the aerosol sample, that makes it possible to study the condensation activity of aerosol particles. The inverse problem was solved for the obtained optical characteristics by iteration method. The range of variation of the real part of the refractive index was 1.38 to 1.56 and imaginary part changed from 0 to 0.04. The particle volume distributions $dV(r)/dr$ were reconstructed. The values of the complex refractive index were estimated by the minimum discrepancy of the reconstructed optical characteristics.

Temporal behaviors of the refractive index and total volume of particles are presented, the relations between them are analyzed. The data on the variations of the parameter of condensation activity of aerosol particles and some optical characteristics are presented.

D1-28

SIMULATION OF INTERACTION OF GASES WITH WATER DROPLET SURFACE

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The mechanism of mass accommodation is universal mechanism functioning at the boundary between gas and condensed phases and determining the transport of gas molecules into the condensed medium. The experimentally measured mass accommodation coefficients of some gases by water surface are quite exactly described by the model [1–2]. According to this model, the accommodation capture of gases by water surface occurs in two stages. On the first stage the gas molecules are adsorbed by the surface. On the second stage they can either be dissolved in water, or be desorbed from the surface. It is conventional to represent the constant determining the equilibrium distribution of gas between the fluxes of dissolved and desorbed molecules as a temperature dependence on the Gibbs free energy.

It is accepted in the model [1–2] that accommodation capture of gases occurs due to formation of critical nuclei. The model ignores the difference in thermodynamic characteristics of the gas molecules and surrounding molecules of water. The model provides simple analytical formulas relating the free energy value with the experimental parameters (temperature and pressure of vapor near the surface), critical cluster size and thermodynamic parameters of water (coefficient of surface tension, enthalpy and entropy of condensation).

Modernization of the model [1–2] is proposed in this paper based on the use of the homogeneous bimolecular nucleation theory.

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D2-01

SIMULATION OF THE GLOBAL METHANE CYCLE

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The problems related with the possible change of climate due to the increased concentration of trace gases in the atmosphere attract now a rapt of attention. On of the urgent problems is numerical simulation of the global cycles of the principal heat-catching gases, including methane (CH_4) which play the important role in radiative transfer and photochemical reactions in the atmosphere.

This paper presents the results of simulation of the global seasonal distribution of methane in the atmosphere on the basis of the 3D climatic model. The model of general circulation of the atmosphere makes it possible to select and estimate the total annual content of methane in the atmosphere. Analysis of the seasonal change of fluxes allows to show what processes dominate in one or another season. Development of the numerical simulation of the global cycle of methane in the atmosphere together with qualitative long-term series of data on the methane concentration make it possible to enhance the reliability of the estimates of the possible climate changes.

D2-02

GEOINFORMATION ANALYSIS OF ATMOSPHERE POLLUTION IMPACT ON LANDSCAPE OF SIBERIAN OILPRODUCTION TERRITORIES

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The purpose of this paper is presenting the results of assessment of ecological impacts of atmospheric pollution resulting from burning of accompanying gas in the plumes arranged on the oil-deposit areas on the forest-wetland complexes of West Siberia as function of the oil production quantity. The essence of the geoinformation approach to assessment of the effect of oil production proposed in this paper lies in combination of health and landscape-geochemical approaches to assessment the impact on environment. Polluted areas were determined by means of simulation of spread of pollution in the atmosphere according to the technique accepted in the nature preservation practice. Investigations were carried out using the data on air pollution based on ecological certificates of oil deposits on the key section (KS) area of 12.8 thousand km^2. The following natural complexes were selected there: wetlands of different type, coniferous forest and pine forest.

The polluted landscape areas related either to the KS area or the total area of the respective landscape type was determined as functions of the oil miming amount by means of overlay drawing of the atmospheric pollution zones on the landscape map by the tools of geoinformation systems. The calculated dependencies were approximated by polynomial models. The plots and parameters of the approximation are presented in the paper.

The effect of the pollution level (in MPC fractions) on the landscape at fixed oil production amount was studied. The dependencies of the relative areas of the polluted landscape are obtained for the present oil production amount at different levels of pollution. The dependencies are well approximated by exponential curves the parameters of which are presented in the paper as Tables.

The results obtained show that the considered approach allows to take into account the dynamics of oil production amount and the amount of gas burnt in plumes, and to follow the temporal change of ecological load as function of both the pollution level and the type of natural complex. The results obtained can be used for ecological assessment of the oil production effect in other areas with similar structure of the landscape.

The work was supported in part by Russian Foundation for Basic Researches (grant "R98-Siberia" N 98-05-03174).

D2-03

STUDY OF ANTARCTIC OZONE HOLE USING TOMS/EP SATELLITE DATA

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The total ozone content (TOC) at latitudes to the south from 35°S since September 6 till December 11, 1998 is studied. The corrected data (level 2) of the TOMS/EP satellite in UV range were used. The TOC field in spring 1998 had the shape of the ring with enhanced TOC surrounding the area with low TOC (ozone hole). The ring diameter on September 30 was about 7000 km, maximum TOC in the ring was 486 D.U., minimum TOC in the hole was 90 D.U. The role of the Antarctic circumpolar vortex in redistribution of ozone between the ring and the hole is discussed. TOC in the ring area and in the hole were compared using the correlation-extreme algorithm. The angular velocity of the circumpolar vortex rotation was estimated as 6.1°/day on September 30. In this case ozone was used as an indicator allowing to follow the motion of the atmosphere.

D2-04

ANALYSIS OF THE AEROSOL CONCENTRATION FLUCTUATIONS

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Investigation of the aerosol number density fluctuations is interesting due to the problem of deserting and emission of aerosol from the underlying surface.

The results are analyzed of measurements of temporal variations of the submicron aerosol number density under convective conditions in Moscow region and in desert area near Aral Sea. Typical regimes of fluctuations and generation of submicron aerosol by underlying surface are revealed. It is shown that in the cases when one can consider submicron aerosol as a conservative admixture, the observed spectra are often close to the inverse-power ones. The inclination of spectra increases under conditions of intensive splash generation of submicron aerosol by the underlying surface of desert area.

The variations of the submicron aerosol number density were studied using the wavelet analysis in order to reveal the structure on the characteristics frequencies of the convective motion.

Separate events, including aerosol splashes are analyzed.

D2-05

THE ROLE OF MICROPHYSICAL AND DYNAMICAL PARAMETERS IN THE ATMOSPHERE REGULATING PROCESSES

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The problem of atmosphere regulation is becoming progressively important. Though a considerable part of society is against of any large-scale attempt to intervene in atmosphere processes this problem requires to be solved. It is also absolutely obvious that in this field there shall be wide international cooperation and consent.

The majority of research experiments use methods of introducing dispersed reagent in the part of atmosphere where a change of thermodynamic condition in the part of atmosphere where a change of thermodynamic condition is needed. Gas reagent, ions, air with considerably different temperature can also be introduced.

Laboratory tests showed the effectiveness of these methods. However natural conditions might give absolutely different results from those estimated on the basis of the laboratory tests and theoretical calculations. The reason for this is that the dynamic as well as the microphysical parameters of atmosphere are hard to model in a lab. In particular it is not possible to model the effect of turbulent friction.

We suggest to cinsider natural experiments in modelling microphysical and dynamical parameters and processes in atmosphere.

D2-06

ABOUT EXTENSION OF OPPORTUNITIES OF THE MARCHUK METHOD THE DECISIONS OF "INVERSE" TASKS OF ATMOSPHERIC IMPURITY DISPERSION

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The problems of description of the spread of aerosol and gas pollution of the atmosphere is usually divided into two classes. The first is solving the "direct" problems, when it is required to assess the admixture concentration field from the known characteristics of its sources. The second is solving of "inverse" problems, when it is required to assess the type, coordinates, power and other applied characteristics of the source of admixture from the data on its concentration in a number of control points. The Marchuk method is based on constructing the problem conjugated with the semi-empiric equation of turbulent diffusion. Then the dual representation of the functional of the mathematical expectation of the concentration makes it possible to solve a lot of "inverse" problems of the spread of admixtures in the atmosphere without resorting to the multiple solution of the direct equation. The area of applicability of such method is limited by the fact that it uses only the mathematical expectations of the concentration. The spread of atmospheric admixtures is the random process, and so the whole class of practically important problems requiring attraction of the concentration distribution laws and knowing the statistical characteristics is not soluble by this method. This paper is devoted to generalization of the Marchuk method to such problems. The paper presents the theory of the method and considers the specific practical examples. In particular, the problem is solved of the optimum arrangement within the precincts of the city of Novosibirsk of an enterprise emitting some prescribed quantity of admixture into the atmosphere. The condition was stated that the

concentration of admixture in the central part of the city were less than the maximum permissible value with the prescribed probability. The relationships obtained in the paper essentially extend the possibilities of the Marchuk method and allow one to solve the inverse problems of the spread of atmospheric admixtures with attracting the data on their concentration distribution laws.

D2-07

NUMERICAL SIMULATION OF AIR POLLUTION ABOVE SOUTH BAIKAL AREA AT LOCAL WINDS

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Atmospheric aerosol spreading depends on meteorological conditions, orographic nonuniformities of relief, transformation of substances because of chemical conversions as well as on interactions of pollutants with te Earth's surface. By the present several papers dealing with experimental studies of atmospheric aerosols around Lake Baikal are published. Due to such studies, a diagnostic image of pollutions distribution is obtained. However, in order to forecast some areas selected it is more perspective to combine complex measurements including using numeric experiments on mathematical models. In numerical simulating of pollutants transfer in mesoscale boundary layer there appears a problem of recovery of the meteorological fields caused by absence of regular observations over water surface and mountain regions difficult of access. For describing the mesometeorological processes occurring above the thermal and orographic nonuniformities of an underlying surface were use nonlinear nonstationary 3-D Euler model.

The analysis of processes of sulphur and nitrogen combinations distribution and transformation above the Southern Baikal was carried out using non-stationary spatial numeric model based on hemi-empiric equation of turbulent diffusion. Numerical experiments with this model were carried out. Their aim was to study the behaviour of admixtures at North-Eastern, South- Eastern and Western wind flows. The results of calculations by this model showed, that main contribution in the pollution of the atmosphere in the Southern part of the lake with dust, sulphur and nitrogen combinations is done by Baikalsk Pulp and Paper Plant (BPPP) and Slyudyanka city enterprises, and the influence of Irkutsk is much less important which is due to its remoteness from Lake Baikal and to orographic obstacles between them - these are Primorsky Ridge and Olkha Plateau. Therefore in the present paper, only discards of sulphur dioxide and nitrogen oxide from BPPP and Slyudyanka enterprises were considered. In the radius 10 km from discard sources in North-Eastern, South-Western and North-Western diractions the calculated concentrations sulphur do not exceed 0,1 mg/m^3, nitrogen – 0,05 mg/m^3, in South-Eastern one – along lake shore- the respective concentrations low than the same values are noticed at the distance of 15 km. Hence, the discards of enterprises of near-shore zone influence much more negatively to Southern Baikal at Western wind with the rate of 5 m/s than at North-Eastern and South-Eastern ones with the same rate. At the influence of North-Eastern flow the admixture is concentrated mainly near discards sources like at calm; the pollution of Khamar-Daban Range slopes with secondary admixtures, more serious than at Western flows, takes place. South-Eastern wind causes the transportation of pollution into Irkut River valley.

D2-08

OBSERVATIONS OF ECOLOGICAL STATE OF EARTH'S SURFACE AND NEAR-EARTH ATMOSPHERIC LAYER ALONG DIRECTION SOSNOVY BOR - NORTH-EAST OF ST.PETERSBURG

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The measurements of ozone, nitrogen oxides and aerosol concentrations as well as element compound of aerosol, water, soil, vegetation and bottom deposits were carried out in different points of southern coast of Finnish gulf. In some places of coast were taken water samples to analyze oil contents. A hypothesis of pollution transportations along north-east direction were tested but not surely confirmed. the preliminary data were collected to observe the evolution of environment pollution in the considered region.

D2-09

WAVELET ANALYSIS OF QUASIPERIODICAL STRUCTURES IN ATMOSPHERIC BOUNDARY LAYER

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When analyzing convective processes in the atmospheric boundary layer and the aerosol spatial distribution inhomogeneities related to it, it is interesting to apply 2D analysis in the distance-frequency coordinate capable of revealing the periodic structures. Fourier transformation and wavelet analysis are applied most often.

To analyze the quasi-periodic convective structures studied at lidar sounding of the atmospheric boundary layer, we used the methods of spectral and wavelet analysis which allow to quantitatively estimate the horizontal scales of aerosol inhomogeneities.

It should be noted that the boundary effects are strong when using the adjacent Fourier transformation with a rectangle window. To suppress these effects, one should apply the orthonormalized wavelets as basic functions. The basis of functions proposed by Morley, which is characterized by the smooth decrease at the boundaries and single maximum in the frequency range. Application of the wavelet analysis of the data of lidar sounding obtained in airborne experiment in Kalmykia on June 19, 1996 is considered in this paper. Vertical distribution of aerosol particles at sounding to nadir was studied by means of the pulse lidar. The distributions obtained were averaged over the height at the distance of up to 300 m from the aircraft.

If the thermic regime of convection has been realized in the atmospheric boundary layer, the inhomogeneity scales are usually characterized by great number of spatial frequencies that causes some difficulties in determining the quantitative characteristics and peculiarities of the aerosol distribution.

The periods of horizontal inhomogeneities from 4.8 to 8 km with smooth transition from one to another were revealed by the wavelet analysis. Such structures were not revealed by usual Fourier transformation.

D2-10

SURFACE OZONE VARIABILITY IN EUROPEAN CENTRAL RUSSIA

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Regular surface ozone (SO) data from Dolgoprudny (forest-park suburb 25 km north of the centre of Moscow) obtained since March 1991, were analyzed. SO changed there from 0-1 to 110 ppb. The SO seasonality may be well described by only 1-year harmonic. The seasonal night-time SO maximum is observed during period of total ozone maximum; SO day maximum is observed almost two months later, nearer the period of the seasonal temperature maximum. The time series of SO residuals (differences between the actual values and "norms") can be described as linear regression of the series of the meteoparameters residuals. The most important SO predictors are temperature and relative humidity at 14 h LT; their relative contributions are dependent on season. The time series of the SO residuals may be described by autoregression equation of the third order. SO characteristics at Dolgoprudny are compared with ones observed in West Europe. The significant correlation between the time series of SO in Dolgoprudny and Preila, Lithuania (at distance more than 1000 km), are found. Episodes of abnormally high SO (up 75 ppb) are mostly associated with vertical air motions (including stratosphere-troposphere exchange); some episodes (up 105 ppb) in April-September seem to be related with the photochemical processes that are similar to the ones observed in Los-Angeles smog.

D2-11

SPECTRAL METHODS OF THE ANALYSIS OF THE STRUCTURE OF THE AEROSOL CONVECTIVE BOUNDARY LAYER

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Convective boundary layer of the atmosphere is formed under combined effect of a number of stochastic and regular processes. This processes can display themselves in the regime of formation of the aerosol spatial distribution in the boundary layer and, in particular, in the observed aerosol structures.

To analyze the quasi-periodic convective structures observed at the lidar sounding of the boundary layer of the atmosphere, we used the methods of spectral and "coordinate" analysis which make it possible to quantitatively estimate the horizontal scale of aerosol inhomogeneities.

The spectral analysis allowed us to reveal three characteristics frequencies. They correspond to the horizontal scale of 10, 4.5 and 2.4 km. The results obtained are in good agreement with the data on the scales and periods of the cell convection at cumulus clouds, the characteristic size of which is 4 km.

D2-12

INTERPOLATION OF MESOSCALE GEOPOTENTIAL FIELD INTO ATMOSPHERIC BOUNDARY LAYER APPLIED TO THE PROBLEM OF NUMERICAL FORECASTING OF AIR POLLUTION

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A problem of an estimation and a forecasting of air pollution processes for local and regional level occupies a significant place in the modern problems of atmospheric and ecological monitoring for limited areas. This problem is solved on the base of the impurity transport equation that is usually realized for the atmospheric boundary layer (mainly a spatial spreading of a man-caused pollution is observed here). As a rule the horizontal wind vector components in points of some regular grid are used for solution this equation However, the geostrophic approaches of wind field by the geopotential data used sometimes in order to constructing this field for want of wind measurements or incomplete aerological network. So, the problem of constructing of mesoscale geopotential field comes up. This problem have not yet solved up to now.

The original combined algorithm based on the procedure of integration of the modified method of clustering of the arguments with the method of optimum interpolation is suggested for its solving.

This paper presents the description of the combined algorithm as well as the results of its accuracy appraisal conducted by the long-term data at 5 aerological stations, presented the typical mesoscale proving ground, and for 6 isobaric surfaces: 975 (~0,25 km), 950 (~0,75 km), 900 (~1,0 km), 985 (~1,25 km) and 850 hPa (~1,5 km).

The combined algorithm is found to give reasonably results, the quality of the objective analysis of the geopotential field at 850 hPa level being 1,7–2,7 times that of the conventional method of optimum interpolation.

D2-13

THE CHANGE OF THE COMPOSITION OF AIR WHEN ATMOSPHERIC FRONTS PASS

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It was revealed long ago that the most significant changes of the optical properties of the atmosphere are related to the formation and motion of the main objects of the general circulation: front cuts, cyclones, anticyclones, troughs and ridges. However, in spite of numerous investigations of the composition of air carried out in different physico-geographical regions, the features of its change in principal synoptic objects are still bad studied.

Possibly, it occurs because of the fact that measurement of the composition of air are performed most often episodically but have not monitoring character. Due to the variety of synoptic situations realized in an episodic experiment, one had not succeeded to collect the statistically provided bulk of data for any synoptic object during limited time.

In this paper based of the results of measurements of aerosol and gas composition of air at the TOR-station in 1999 we consider the change of the composition of air when atmospheric fronts pass.

Atmospheric fronts are selected for the consideration, because S.P. Khromov showed in 1948 that the turbidity factor is distributed uniformly inside an air mass and spasmodically changes in the frontal zone [1]. It was theoretically predicted in Ref. 2 that the change of the ozone concentration in the cold front zone should be spasmodic, and the necessity of experimental examination of this prediction was suggested. Hence, one can suppose that the transition from one air mass to another should be accompanied by the sharp change of the composition of air.

The front position was determined using the pressure maps at different altitudes.

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D2-14

SIMULATION OF SPREADING AND TRANSFORMATION OF SULPHUR AND NITROGEN COMBINATIONS IN THE ATMOSPHERE OF SOUTHERN REGION A ROUND LAKE BAIKAL

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The processes of interaction of chemical substances emitted by industrial enterprises of Angara region, Baikal region, Selenga valley, and Gusinoozersk were studied using the numerical model. Stationary sources of sulfur and nitrogen were taken into

account. Numerical experiments were carried out for different meteorological conditions. The background distributions of the principal components of the atmosphere: oxygen, nitrogen, water vapor and some trace gases were considered as initial conditions. Comparison of the results of calculations and the data of instrumental measurements has showed their qualitative and quantitative agreement. The maps of distributions of concentrations of primary and secondary admixtures in different seasons have been constructed. When analyzing the results of numerical experiments, the contribution has been estimated of each group of industrial enterprises into the pollution of lake Baikal by the products of oxidation of sulfur and nitrogen.

The work was supported in part by Russian Foundation for Basic Researches (grant N 98-05-64021) and Ministry of Education (grant N 97-0-13.3-12).

D2-15

ON THE QUESTION OF ANTHROPOGENIC EFFECT ON CONCENTRATION OF OZONE AND AEROSOL IN THE NEAR-GROUND LAYER OF THE ATMOSPHERE

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The problem of anthropogenic effect on environment becomes urgent last years. In this connection, field measurements of ozone concentration and aerosol number density were carried out simultaneously in the city of Tomsk and village Kireevsk by means of analogous instrumentation. Expeditions were carried out in July-August 1997 and 1998 and October-November 1999.

The data obtained in Tomsk were considered as urban, and in Kireevsk as background.

The results obtained are interesting. Diurnal behavior of ozone in Tomsk in 1997 is presented by one- and bimodal curves with equal probability, and by one-mode curves in 1998. Only one-mode distribution were observed in Kireevsk in this period. Predominance of such shape of diurnal behavior in 1998 is more likely explained by the minimum of industry. After it some changes in concentration and distribution of ozone occurred. Both types of curves were observed in Tomsk and Kireevsk in October and November 1999. It is revealed that the diurnal amplitudes of ozone variations in summer are greater in Kireevsk than in Tomsk. The inverse situation is observed in fall. Besides, the cases with non-pronounced diurnal behavior are observed in Tomsk and Kireevsk both in summer and fall.

In spite of the fact that Kireevsk is 60 km far from Tomsk and is in the same climatic zone, diurnal behaviors of ozone at these sites are different that is evidence of different sources of emission of this gas into the atmosphere.

When analyzing the aerosol number density, we also obtained an unexpected result. In the majority of cases the aerosol number density is greater in Kireevsk than in Tomsk.

D2-16

AEROSOL AND RADON STREAMS VARIABILITY IN A TECTONIC FAULT ZONE

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Search of the phenomena previous to an earthquake and, so, able to be a predictor is the important scientific–technical problem. The increase of accuracy of the earthquake prediction is possible at the comprehensive study of the natural objects the characteristics of which change before the earthquake. Such objects can be aerosols, natural radon and electric properties of the atmosphere. Experimental investigations of their characteristics were carried out in October 1999 at Taman peninsula in the tectonic fault zone where the enhanced seismic activity is observed. The aerosol characteristics were carried out by means a device capable of measuring the intensity of scattered radiation at an angle of 45°. The data on the radon distribution were obtained by means of the network of scintillators situated in the tectonic fault zone. The intensity of the electric field of the atmosphere was measured by means of the sensor of dynamic type, the conductivity of air was measured during the discharge of the volume capacitor.

A few powerful earthquakes occurred during the period of measurements. The radon flux intensity increased before the increase of seismic activity and then sharply decreased at the earthquake.

The increase of the intensity of the electric field of the atmosphere was observed before the earthquake that then also sharply decreased at the earthquake.

The conductivity of the atmosphere also decreased replaced with the increase after the earthquake.

The data characterizing the intensity of aerosol lightscattering over the tectonic fault zone show the analogous temporal behavior.

On the whole, the results have confirmed the perspective of these investigations and the necessity of their continuation.

D2-17

ELEMENTAL COMPOSITION OF AEROSOLS OVER THE FORMER USSR

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In this paper we present some results of the comparison of aerosol elemental composition over different climatic and physicogeographical regions such as West Siberia and Kazakhstan Aerosol sampling had been performed onboard aircraft laboratory within 100 to 7000 m layer of the atmosphere. We analysed 423 aerosol samples for Kazakhstan region and 1416 samples for West Siberia. The comparison showed that elements of the terrigenous origin (Si, Al, and NO_3^+ and Cl^- ions) are prevalent for both regions. In west Siberia it was observed high content of bromides. Percentage of microelements differs insignificantly. Vertical distributions of Ca, Si, Fe, Na^+, NO_3^+, and Cl^- over Kazakhstan and West Siberia have common features. It is confirmed by high pair correlation coefficients between them. A big number of samples enabled us to compare annual behaviour of element concentrations observed over these regions. Terrigenous elements (Si, Al, and Fe) have a well-defined annual behaviour in West Siberia as well as in Kazakhstan. Analysis of synoptic and meteorological data allowed us to isolate some features of the element composition of aerosols depending on air mass type. Maps of the horizontal distribution of concentrations of some elements showed that at the prevalent winds of south-western direction over West Siberia it is observed transport of aerosols from Kazakhstan. Thus, we can draw a conclusion that element composition of aerosol and its spatio-temporal distribution depend, in high degree, on physicogeographical conditions and air mass type.

D2-18

MEASUREMENTS OF METHANE BACKGROUND CONCENTRATION IN WINTER PERIOD, 2000, IN TOMSK

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Methane is an active gaseous component of the greenhouse effect, and its monitoring is of practical importance for climatology, particularly, in the territories of its formation (boggy systems, rice fields) in spring and autumn seasons. We present in the paper the results of routinely measurements of its background concentration in the territory of Tomsk suburb (Academy town) from March to May, 2000.

To measure the methane concentration, we used gas-analyzer with tunable diode laser. The laser radiation frequency is tuned by means of current and temperature in the range 6000–6080 cm^{-1} (1.645–1.666 mm wavelength). The tuning is performed by the diode laser temperature variation and stabilization with the help of built-in Peltier element. The laser radiation power is 3 mW. Optical unit of the gas-analyzer incorporates the diode laser, two optical cells (a multipath cell with tunable length of optical way (analytical channel) and the reference one), and two photodetectors located in the reference and analytical channels. The threshold sensitivity of the methane gas-analyzer is 0.04 ppm. The measurements were conducted under conditions of continuous blowing of the air samples through the multipath cell at day time from 10 a.m to 6 p.m.. The measurement cell volume was 15 l, blowing speed – 7.5 l/min. The time constant was 5 minutes. Zero calibration was made three times a day by means of pure nitrogen blowing through the cell.

The value of CH_4 concentration in the atmosphere (day time) changes from 1 to 2.2 ppm. As the result of these measurements, we have analyzed the correlations in variations of the methane and ozone concentration monitored at the IAO station of atmospheric monitoring.

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D2-19

PECULIARITIES OF THE SEASONAL VARIABILITY OF THE NEAR-GROUND OZONE CONCENTRATION IN THE ATMOSPHERE OF BAIKAL REGION

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It is known that the ozone concentration in the atmosphere determines the quality of air, so the study of its variability is important. Investigation of the causes of the change of the ozone concentration requires to attract the data on the concentration of other chemically active admixtures (including nitrogen oxides), radiative and dynamic parameters of the near–ground layer of the atmosphere.

Laboratory of Radiophysics of the Department of Physical Problems BSC SB RAS together with Institute of Atmospheric Optics SB RAS carry out comprehensive investigations of the peculiarities of the spatial–temporal variability of aerosol and gas admixtures in the region of the city of Ulan–Ude and south–east coast of lake Baikal.

The results of measurements of the concentrations of ozone and nitrogen oxides in the region of the city of Ulan–Ude and south–east coast of lake Baikal (village Boyarskii) in January, May and June 1999 are presented in this paper.

The diurnal behavior has been revealed of the near–ground ozone concentration in different seasons in Ulan–Ude.

Analysis of the season variations of the ozone concentration in Ulan–Ude has shown that the greatest concentrations O_3 are observed in summer (66 ppb), and minimum is in winter (9 ppb).

The daily mean concentrations of O_3, NO_2 and NO in the coastal zone of Lake Baikal (village Boyarsk) in summer are 60 ppb, 50 $\mu g/m^3$ and 15 $\mu g/m^3$, respectively.

The paper presents the approximate calculation of the generation and destruction rates of the near–grouns ozone in the coastal zone of lake Baikal. The estimate of the generation and destruction rates of the near–grouns ozone allows us to conclude that the photochemical processes are the principal mechanism of generation and destruction of ozone in summer.

The work was supported in part by Russian Foundation for Basic Researches (grant N 97–05–96449), Ecological Foundation of Buryatia, and the project ROLL N 113–3 funded based on the Agreement of cooperation between Institute of Stable Society (USA) and AMR.

D2-20

ISOLATION OF THE LOCAL ANTHROPOGENIC COMPONENT OF ATMOSPHERIC AEROSOL BY SYNCHRONOUS SAMPLING OF THE NEAR-GROUND AEROSOL

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The problem of global climate warming is one of the important problems and the aerosol plays a significant role in this process. Does this atmospheric component result in the increase or decrease of global temperature? The answer is ambiguous. It's also difficult to estimate anthropogenic contribution in atmospheric aerosol composition. However, in terms of physicogeographical peculiarities of the region and air mass transport regularities, it's probably to do for the particular region.

Thus, we try to estimate amount of anthropogenic aerosol components formed in the individual region. The investigation has been performed in July-August 1997–1998, October-November 1999 in Tomsk and nearby region. We have carried out synchronous aerosol sampling using two identical samplers with Petryanov's filters near Tomsk (urban area) and near Kireevsk (rural area, 60 km westerly Tomsk). We suggested that the difference in aerosol chemical composition between Tomsk and Kireevsk could depend on anthropogenic contribution of Tomsk at the presence of western or eastern air transport. The observed concentration gradients and correlation's are quite reliable to be indicators of the anthropogenic fraction of the atmospheric aerosol.

D2-21

SPATIAL DISTRIBUTION OF CHEMICAL COMPOSITION OF ATMOSPHERIC AEROSOL OVER RUSSIA

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We present spatial distribution of the ion and elemental composition of atmospheric aerosol in lower troposphere. Analysis of data is based on the aerosol sampling performed on board aircraft withing 500 to 3000 m layer from 1983 to 1989. We surveyed following regions: south of european territory of Russia, Urals, North Kazakhstan, West Siberia, East Siberia, Far East and Kamchatka.

We used Petrynov's filters for aerosol sampling. Than these samples have been analyzed at analytical chemistry department of Tomsk State University using certified techniques.

Statistic analyzes of results provided to obtained correlation in spatial distribution of aerosol. Also, we compared the relative distribution of chemical components with that content in soil. It is provided to divide quantitive mineral and anthropogenic fractions of aerosol, and to determine souses regions for some ions and elements. For example, North Kazakhstan is the significant producer of soil elements, whereas Ural is characterized by increased content of anthropogenic elements. Significant concentration of some elements over Kamchatka is explained by volcanic activity in this region.

D2-22

DYNAMICS OF THE VERTICAL DISTRIBUTION OF AEROSOL OVER WEST SIBERIA (1997–1999)

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In this paper we present data on vertical distribution of the number concentration of aerosol particles ($d > 0.4$ micron) acquired over west Siberia and discuss some results of preliminary analysis of these data.

The flights have been performed monthly starting from July 1997 and until December 1999 over a forested area near Kamen' on Ob', Novosibirsk region at the heights from 0.5 to 7.0 km. This region is situated to the west from big industrial centers thus being free from the influence of atmospheric emissions from these centers because of the prevailing westerly air mass transfer in this region. For these reasons the region under study can be considered as a background one.

Accumulation of aerosols during wintertime occurred only in the boundary layer of the atmosphere below the altitude of 2 km because of a strong temperature inversion there. This type of the aerosol vertical distribution evidences the fact that during wintertime in this region there is only one source of aerosol near the underlying surface and that this source does not contribute to the above laying layers. No remote sources of aerosol contributing to the aerosol overburden of the atmosphere over this region can be revealed from these data either.

In the springtime the underlying surface in the southern part of the Eurasian continent gets free from snow cover and the aerosol forming substances start to inflow into the atmosphere. It is most likely that for this reason vertical profiles of the aerosol distribution acquired at that time in the region under study exhibit some features that indicate the presence of long-distance aerosol. These processes last almost during the entire spring period. Besides, the rapid increase of the aerosol concentration evidences the fact that the aerosol is generated in the neighbor regions.

In summertime the underlying surface is well warmed and, as a result, a well-developed turbulence is observed in the atmosphere over the region under study. This, in turn, causes the aerosol vertical profiles to straighten due to efficient air mixing.

In the autumn the aerosol vertical distribution has a transient shape. In the beginning of this season it is close to the summer one, so being characterized by lower aerosol concentration due to washing out by precipitation. By the season end the aerosol vertical distribution takes the shape that is closer to the winter one because of the snow cover that establishes at this time.

The data of airborne sounding of atmospheric aerosol performed on a routine scale in 1997 to 1999 have shown that the aerosol number concentration, in the atmosphere over west Siberia, has typically seasonal features in the behavior of its vertical distribution that are caused by the joint effect of local and remote sources of aerosol particles. It was revealed in this study that the amplitude of time variation of the aerosol concentration at different heights keeps practically constant that also is a consequence of the joint effect of local and remote sources of aerosol particles.

D2-23

ASSESSMENT OF A CONTRIBUTION OF NO2 TO THE AEROSOL FORMING PROCESSES

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In 1996 we have performed monitoring of ultrafine and fine aerosol particles (d < 200 nm). It enabled us to reveal some features in diurnal behavior of their number concentration. But per se diurnal behavior dose not explain the particle nature and the processes of their formation and transformation in the atmosphere.

It is well known that the main source of aerosol particles with the diameter less than 0.1 μm are gaseous impurities. As a result of chemical and catalytic reactions in the atmosphere the aerosol forming substances are formed. Nitrogen dioxide is one of the gas precursors of aerosols. The main source of this gas in rural areas is the underlying surface. Authors of Ref.1 revealed those local emissions of NO and NO_2 can occur from forest ecosystems. In this paper we present some results of monitoring of the NO_2 and ultrafine and fine aerosols in the 0.003 to 0.2 μm diameter range that was performed at the TOR-station of IAO in December 1998. This station is located in the boreal zone. Analysis of the data obtained during this monitoring has allowed us to reveal an explicit diurnal behavior of concentrations of both of these atmospheric components and an interrelationship between their dynamics. During some periods the correlation between them reached 0.6856. Time behavior of the nucleation mode (d < 0.02 μm) is very unstable. At the presence of high and low concentration of larger particles (d > 0.02 μm) the nucleation mode was not observed. Therefore we decided to estimate a contribution from NO_2 to the process of the initial aerosol formation and to determine conditions under which nucleation mode is formed. Physical and chemical processes that take part in the nitrate cycles are quite numerous, because nitrogen dioxide can be oxidized in several ways. Thus, the nitrate monomers are formed as a result of chemical and photochemical reactions. They can condense on existing aerosol particles or homogeneously grow, thus forming ultrafine aerosol particles. The existing particles of d < 20 nm can be an indicator of a homogeneous process. Having know the size of the initial particles formed from the gas phase, number concentration and mean diameter of the nucleation mode of aerosols we have calculated relative number of the initial monomers participated in the formation of the nucleation mode particles. This approach was well explained in Ref. 2 where authors used it for the sulfuric cycle.

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D2-24

DIURNAL BEHAVIOR OF THE CONCENTRATION OF ULTRAFINE AND FINE PARTICLES

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It is very important to study a temporal variability of aerosol in order to understand the processes of its formation and transformation in the atmosphere. In this paper we present some specific features revealed in the diurnal behavior of the secondary aerosol that is formed directly in the atmosphere from the gas phase. Although, *per se* diurnal behavior does not explain the origin and transformation processes of aerosol, but if we understand its specific features we will be able to proceed to a purposeful study of the processes that determine aerosol life based on known theoretical studies (Ref. 1).

In 1996 we have performed a monitoring of the disperse composition of aerosols in the 3 to 200 nm diameter range that allowed us to reveal a well pronounced diurnal behavior of the concentration of ultrafine and fine aerosols (Fig. 1).

Figure 1 shows that the presence of well-pronounced night-time minimum in the diurnal behavior is its characteristic feature in all seasons. Due regard must be given to the fact that the diurnal behavior has a broad daytime maximum (total number concentration of aerosols varied slightly). It evidences of the equilibrium between the generation and sink processes during the daytime.

Diurnal behavior of nucleation mode particles is presented in right-hand panel of Figure 1. It has a well-pronounced daytime maximum. According to Ref. 2, the presence of the nucleation mode particles can be an indicator of homogeneous process of the aerosol formation. Therefore, such a behavior of the concentration of these particles can be explained by the strengthening of this process during daytime, when photochemical reactions become more intense and produce a sufficient amount of aerosol forming compounds. In this case we should study what substances take part in the homogeneous aerosol formation and under what conditions it occurs.

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D3-01

INVERSE PROBLEMS AND ATMOSPHERIC MONITORING INFORMATIVE QUALITY

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The questions are considered of organizing the interaction of mathematical models and the monitoring systems in the modes of direct relations and feedback in order to study the conditions of formation of atmospheric processes and transfer of pollution.

Such an approach determines the specific requirements to the model structure and algorithms of their realization. In particular, they should be able to be developed and provide the optimum estimates of the goal functional and functional of observations relatively to the variations of the functions of state. So the numerical models are constructed by means of the variation principle. They include the systems of main and conjugated problems and the algorithms for calculating the functions of sensitivity. The technique is based on the principles of direct and inverse simulation. To realize the transfer models, the combined Euler and Lagrange forms of algorithms are used together with the Monte Carlo methods.

The conception is discussed of revealing the areas of enhanced ecological vulnerability to the consequences of anthropogenic impact. Its central part is the problems of the "source-detector" and "detector-source" type. The problems of the information capacity of the systems for monitoring are solved from the standpoint of sensitivity and ability of observation for identification of the specific pollution. The problem of using the mobile and stationary observation systems is analyzed by means of the imitation simulation. The areas of information capacity and their variability are compared.

These problems are effectively solved in the frameworks of the scenario approach. The simulation system is created for this purpose, that contains the information, diagnostics and forecast models. The principal statements of the paper are illustrated by solutions of the specific problems.

D3-02

ON LOW-DIMENSIONAL CLIMATE MODELS

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Although the developed 3D climatic models are available in many research centers, the interest to the simple models does not become weaker. This interest is based on the desire to visually represent the principal laws controlling the climatic system. The simple global models appearing in 70-th have shown that, in spite of the variety and big number of the factors affecting the climate, the principal features of the climate evolution are described by them quite adequately.

It is universally recognized now that the climatic system if highly non-linear, and, in principle, can demonstrate the catastrophic peculiarities. It is clear, that big models are badly suited to determining the qualitative peculiarities of such type. At the same time, investigation of the problem of the possibility of global catastrophes begins to pass from the scientific discussion to the practical problems. Then it is reasonable to retrospectively consider the simple models.

The behavior of temperature was studied in the simple climatic models in order to reveal the appearance of multiple states and their stability. However, then the accent in study of the non-linear phenomena moved to the area of 3D dynamics. Let us consider here the vertical distribution of temperature, in order to describe the different approach from one point of view, and owing to this to reveal the qualitative features which were not considered earlier. Let us also propose the simple radiative model which tolerates the application of qualitative investigations for analysis of the vertical distribution of temperature and some results obtained.

D3-03

INTEGRATED WEB INFORMATIOM-COMPUTATIONAL SYSTEM "ATMOSPHERIC OPTICS"

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Reported is the description and current state of the Internet accessible integrated information-computational system "Atmospheric Optics". The system will join gathered at the Institute of Atmospheric Optics results of experimental and field measurements of optical characteristics of atmosphere with developed theoretical models for computation and prognosis of the optical properties of the atmosphere. The system integrates currently the following interrelated topical subsystems: atmospheric chemistry, atmospheric radiation, molecular spectroscopy and aerosols designed on the base of Internet technologies as sites in the Web.

D3-04

WEB ICS "ATMOSPHERIC CHEMISTRY". FIRST RESULTS

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Web information-computational system "Atmospheric chemistry" is a part of the project "Integrated model "Atmospheric optics" which is funded by RFBR grant (99-07-90104).

A short review of applications, logical models, data structure and special services is presented. A computational block of the system for making qualitattive analysis of kinetic equations is described. The cluster technology for calculation time reduction is used. The first results of 2D and 3D systems (ozone cycle [1], oxygen-hydrogen mesosphere [2]) qualitative analysis (phase portraits, stability analysis, relaxation time hierarchy, ...) are demonstrated.

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D3-05

WEB INFORMATION SYSTEM: ATMOSPHERIC SPECTROSCOPY

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The structure, functions, actual state and perspectives of development of the "Atmospheric Chemistry" (the part of the "Integrated model of atmospheric optics" project) are presented (grant of Russian Foundation for Basic Researches N 99-07-90104).

The system is destined to Internet access to the data on the parameters of spectral lines (PSL) of atmospheric gases and trace admixtures which are necessary for solving the problems of atmospheric optics.

The PSL database is based on the well-known databases Hitran-98 and Geisa-97. The possibility is rendered to use user's own original data on the spectra. The sample of data can be done in the molecule /isotope /spectral band section or in the prescribed frequency range for the gas mixture selected or suggested by user.

The system can solve the problems of construction of the frequency profiles of the absorption coefficients, transmission and absorption spectra, convolution of the absorption spectrum with the prescribed instrumentation function and its comparison with the experiment, calculation of the transmission function on the vertical and slant paths in optically inhomogeneous media.

All results obtained by the system can be found at the site spectra.iao.ru as table or plot. As well, they can be loaded in the user's computer as text files for subsequent processing by other programs.

D3-06

USE OF THE DATA OF METEOROLOGICAL OBSERVATION AND LIDAR SOUNDING FOR NUMERICAL SIMULATION OF AEROTHERMOCHEMICAL PROCESSES IN THE ATMOSPHERE

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Complex application of mathematical simulation and the results of instrumental sensing of the planetary boundary layer is the perspective method for diagnostics and forecast of the physico-chemical processes in the near-ground layer of the atmosphere, because such an approach combines the advantages of theoretical and experimental ways for studying the natural and technogenic phenomena. The purpose of this paper is the analysis of the ways of optimal using the data of acoustic, ultrasound and lidar sensing of the atmosphere at numerical calculation of meteorological characteristics and concentrations of admixtures. The results of observations carried out for the homogeneous boundary layer of the atmosphere (Wangara experiment, Australia, August 16–18, 1967 and field measurements of IAO SB RAS, Russia, June 7–9, 1999) were used as empiric data at the initial stage of the development of the approach proposed. It was the data on temporal behavior of the near-ground values of the homogeneous boundary layer (temperature, absolute value and direction of horizontal wind velocity, and the intensity of turbulent pulsation), geostrophic wind, as well as the measured vertical distributions of the meteorological parameters at certain time moments. The results of observations were used as initial and boundary conditions for differential equations of the mathematical model of the homogeneous ABL. The mathematical model of the process combines the equations for the horizontal wind components, potential temperature, and specific humidity of the atmosphere. Turbulent structure of ABL was calculated based on the two-parameter

model of turbulence. The Lagrange approach with probability simulation of the turbulent pulsations of velocity was used for the study of spread of pollution from the point source. The constructed calculation procedure was used for prediction of evolution of the cloud of gas and dispersed products of the explosion experiment. The results of numerical simulation are compared with the data of lidar sounding.

The work was supported in part by Russian Foundation for Basic Researches (grant N 98-01-03017).

D3-07

ABSORPTION KOEFFICIENTS DATA BASE. CONCEPTION

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The use of exact methods for calculating the absorption coefficients (AC) based on line-by-line calculations becomes more urgent as infrared high-resolution spaceborne sensors appears, such as, for example, IMG (Interferometric Monitor for Greenhouse Gases). The absorption coefficients are needed both for simulation of the direct problem and for solving the inverse problem of sounding of the atmosphere and the underlying surface by IR sensors. Calculation of the absorption coefficients requires a lot of time for simulation of the outgoing radiation with high spectral resolution. Another important problem where the absorption coefficients can be used, is the problem of simulation of the thermal radiation fluxes.

The conceptual model of the created database of the absorption coefficients of atmospheric gases is discussed in this paper. Two models of the database are considered: the first one includes the quasi-monochromatic absorption coefficient and is destined to solving the problems of spaceborne sounding of the gas composition of the atmosphere; and the second one is oriented to solving the radiative problems and contains the low-resolution absorption coefficients transformed by Laplace.

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D3-08

EFFECTIVE CLOUD FRACTION IN VISIBLE WAVELENGTH RANGE: A NUMERICAL MODEL

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An approach to parametrization of the short–wave radiation fluxes in broken cloud has been proposed in [1]. The approach is based on the use of effective cloud fraction as a parameter. It is revealed that there is simple functional relation between the effective cloud fractions in short–wave N_e^{sw} and visible N_e^{vis} wavelength ranges. That makes it possible to reduce the problem of calculation of the short–wave radiation flux to the calculation of N_e^{vis}. As there are no quick and accurate techniques for calculation of N_e^{vis}, we have developed a numerical model of the effective cloud fraction.

The model is based on the database that includes a) the results of calculations of the upward and downward radiation fluxes (visible range) at different atmospheric levels z and b) the values N_e^{vis} for the wide range of the input parameters of the problem. The input parameters are: the optical thickness of the cloud τ, the cloud fraction N, the parameter $\gamma = H/D$ where H and D are the geometrical thickness and the characteristic horizontal size of the cloud, respectively, $\xi_\oplus$ – zenith angle of the Sun, and A_S – albedo of the underlying surface. The radiation fluxes were calculated at 12 atmospheric levels z = 0, 0.5, 1.0, 1.5, 3.0, 5.0, 7.0, 9.0, 10.0, 12.0, 14.0, and 16.0 km (the cloud layer was situated at z = 1–1.5 km) for the following values of the parameters: N = 0, 0.1, 0.3, 0.5, 0.7, 0.9 and 1.0, γ = 0, 0.2, 0.4, 0.6, 0.8, 1.0, 1.5 and 2.0, $\xi_\oplus$ = 0, 20, 40, 60 and 80°, τ = 5, 10, 15, 20, 40, and 60, and A_S = 0, 0.3, 0.6 and 0.9. the values N_e^{vis} at intermediate N, γ, $\xi_\oplus$, A_S and τ were calculated based on the linear interpolation of the values N_e^{vis} in the "nodes".

The database created in VISUAL BASIC 3 operates under MS Windows 3.1 and MS Windows 95. The version of the database is being prepared now for presenting in Internet.

The developed numerical model of the effective cloud fraction can be interesting for the specialists in the field of geophysics, atmospheric physics and mathematical simulation of the atmospheric processes.

The work was supported in part by Russian Foundation for Basic Researches (grant No. 00–05–65456).

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D3-09

TO THE QUESTION ABOUT IMPROVING PROGRAMME AND ALGHORITHMICAL MAINTENANCE OF THE TASKS OF RESTORING VERTICAL PROFILES OF METEOROLOGICAL VALUES

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The available instruments for remote sensing of the atmosphere are not capable of obtaining the total bulk of data on the vertical distribution of different meteorological parameters. First of all, it is explained by the modern level of development of science and technology. So the physical and statistical methods are actively used for reconstruction of the vertical profiles of meteorological parameters. In addition to the data of remote active and passive sounding, they can cover all height range interesting for users and allow to obtain meteorological data with great resolution and accuracy.

Besides, the algorithms and software for such problems is not yet optimal. We suggest our variant of the algorithm for reconstructing the parameters of the vertical distribution of temperature, relative humidity and ozone partial pressure. The variants of the programs are considered and the selection of the programming languages is stated.

We suggest to realize the service software (formation of databases, selection of sequences, finding missed data, etc.) on TurboPascal 7.0, and to realize the programs for reconstruction by means of group account for arguments, multiple extrapolation and polynomial approximation on Fortran 5.0. the variant of programs are presented, their disadvantages are discussed.

Refining the algorithms, module principle of their operation, making packages with expanded comments make it possible to apply them depending on quantity and quality of the a priori data.

D3-10

DEVELOPMENT OF *LINE-BY-LINE* METHOD

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A number of methods are used now for simulation of the absorption coefficients of atmospheric gases: exact or line-by-line calculation, approximate and empiric methods. Without discussing the advantages and disadvantages of each group of methods, let us consider the line-by-line method, which is now recognize as a standard and is used both for exact calculations of the absorption coefficients and for examination of the approximate methods.

The peculiarity of the line-by-line method lies in the large quantity of calculations and time expenses. We propose the algorithm and software product for quick calculation of the absorption coefficients of atmospheric gases by the line-by-line method.

A number of techniques are used for acceleration: the multigrid algorithm proposed in [1], selection of lines [2], and calculation of the absorption coefficient only in a half of the line contour points. According to the preliminary estimate, the last one makes it possible to get a bonus of up to 70% of time on the Voight contour under favorable conditions.

It is supposed to use the final product as a part of the project "Database of the absorption coefficients of atmospheric gases" that requires including some specific capabilities (autonomous job, checking the errors, etc.).

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D3-11

MATHEMATICAL METHODS OF DATA COMPRESSION

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Absorption of radiation in visible and infrared wavelength ranges is one of the principal characteristics of the atmosphere. It is determined by the concentration of gases contained in the atmosphere. The absorption coefficient $K(\nu, T, P)$ is used for quantitative characterization of the ability of gas to absorb the radiation at the frequency ν at temperature T and pressure P. Application of the absorption coefficient K in the programs for simulation of the radiative characteristics of the atmosphere requires many calculations that is caused by big number of lines to be taken into account. Besides, it is necessary to calculate the value K for different frequency, temperature and pressure. The approach based on single calculation of K at the nodes of some optimal 3D grid from the variables ν, T and P and storage of it as a structured file with possibility of subsequent interpolation at an arbitrary point from the nearest values seems to be reasonable for significant reducing the time of calculation. Construction of such a database is the separate problem that is considered in this paper.

In order the database has a rational size and can be placed on a CD, it is necessary to compress it. The technique for compression of such a database by SVD method is described in [1]. Authors have shown the high efficiency of SVD for compressing the data (~ 73 times) but the database was particularly specialized and covered a narrow wavelength range. The extension of specialization of the database and the frequency range leads to the sharp increase of its size and to the necessity of more strong compression, so the attention was paid for the quite perspective discrete wavelet transformation (DWT). The initial matrix was transformed to the population of the wavelet function coefficients. Then, using some rules, one can neglect the most part of them. The initial matrix is reconstructed from the residual coefficients with some error depending on the number of the neglected coefficients.

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D3-12

NONHYDROSTATIC MODEL OF THE STRATIFIED RESERVOIRS

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The nonhydrostatic 3D nonlinear model of hydrothermodynamic processes of stratified water reservoirs has been developed for simulating the mesoclimate and solving the geoecological problems. The model takes into account the compressibility and all components the Coriolis force. The model is destined for describing the fields of flow velocity, temperature, density of water and admixtures in lakes, water storage pools and other reservoirs of natural and artificial origin. The following equations are included into the system of differential equations of the model: motion, continuity, state, as well as the equations of transfer of heat and admixtures.

Transforming the equation of continuity and heat inflow by means of the equation of state, we obtain the evolution equations for temperature and pressure. Evolution type of equations allows us to construct the economical semi-nonexplicit procedure. The equations of the model are integrated in the Cartesian rectangular coordinate system using the method of fictitious areas. Introduction of such areas makes it possible to perform calculations with an arbitrary function describing the relief of the reservoir bottom. The numerical algorithm for solving the problem is constructed based on the method of dividing according to the physical processes.

The constructed finite-difference procedure is economical, absolutely stable, has first order of approximation of time and second order of approximation of coordinates.

On the one hand, the model allows to describe the large-scale processes (for example, the Coriolis force effect) in the large-size lakes, and on the other hand, the mesoscale phenomena, for example, the thermobar forming the vertical exchange of water in spring and fall occurring due to the different stratification of water in coastal and central parts of the reservoir.

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D3-13

THE MODELING OF FLIGHT VEHICLE EMISSION SPECTRA AND THEIR TRANSFER IN REAL ATMOSPHERE

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This paper presents the created multifunctional software complexes aimed at calculation of the parameters of oscillation-rotation lines and spectral characteristics of absorption and radiation of heated gases (T = 300–2500 K, CO, CO_2, H_2O) in IR wavelength range providing the basis for simulation of irradiation of a flying vehicle flame and the analysis of its propagation in the real atmosphere taking into account all aspects of the transfer of the high-temperature radiation.

Authors have considered the possibility of successive construction of a spectral model of radiation of a flame. It is shown that the databases of spectral line parameters corresponding to specific temperatures with the step of order 300 K are necessary for adequate quantitative description of the flame radiation transfer to the receiver situated under normal atmospheric conditions. The use of one database calculated at fixed even very high temperature (~2000 K) with subsequent conversion of the intensity values leads to the loss of accuracy of calculating the absorption coefficient up to 20%.

As result, new possibilities are suggested for solving the inverse problems of gas composition ad thermodynamic characteristics of the flame. The final goal of this study is creation of the automated ИПС performing the remote diagnostics of operation of the flying vehicle engine using the spectral radiation of its flame and the construction of the spatial distribution of concentration and temperature fields of the flame.

D3-14

APPLICATION OF ODRIS SYSTEM TO REVEAL TEMPORAL AND SPATIAL REGULARITIES IN OZONE AND OTHER ATMOSPHERIC PARAMETERS CHANGES

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ODRIS (Ozone Data Reconstruction and Investigation System) information system is destined to processing and analyzing the miscellaneous data (data of laser and passive sounding, profiles and total content of gas components, near-ground values of meteorological parameters, etc.) in order to reveal the spatial and temporal regularities of variations of the stratospheric components under study.

The system we developed has several items of application which can be considered as independent. The first part is directly related to the "rough" lidar data and processing them in order to reconstruct the sought parameters of the atmosphere (profiles of ozone concentration, temperature or scattering ratio), and the second part of the package is destined to obtaining more full data on the component under study, its relations with other components of the atmosphere and spatial peculiarities of the behavior.

The data on interrelations of the components and parameters of the middle atmosphere were obtained by means of the ODRIS system at the Laboratory of remote spectroscopy of the atmosphere of the Institute of Atmospheric Optics.

The object-oriented approach was used for creating the system. The structure and relations of different algorithms were represented as a graph. Use of the object-oriented technique for realizing the algorithm represented in such way gives noticeable advantages both for researcher by giving a chance to combine different algorithms and for developer by making the system for "clear" and open for subsequent adding the possibilities.

D3-15

ICS "ATMOSPHERIC OPTICS". DATABASES

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The paper presents the structure of data, database projects and information models which are the basis of the created "Atmospheric Optics" IRS. The last versions and structure changes of the database on chemical reaction coefficients, first of all the photolysis reaction coefficients and the database of the statistical models of the atmosphere and spectra of solar radiation are described. The "Atmospheric Models" information system is created based on the last database with Internet access to Table and graphic represented data on the atmospheric parameters. The software is created for direct put down of the atmospheric parameters measured at TRO and aerosol stations into the databases with their subsequent processing and displaying the results on the web-site "Atmospheric Aerosol" of IAO SB RAS in real time.

D3-16

APPLICATION OF OBJECT-ORIENTED APPROACH FOR REALIZATION OF ALGORITHMS REPRESENTED AS ORIENTED GRAPH IN A SOFTWARE SYSTEM ODRIS

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The algorithms for solving some problems can be represented as a graph. The graph nodes are some large blocks of the algorithm. The curves between the nodes mean the sequence of operations from the root to the branches, as well as the fact that some output data of the initial node are input for the next node. Such a representation of the algorithm has a number of advantages for constructing the systems, which are required to not simply solve the problems, i.e. to follow the algorithm, but to give a chance to user to study and select the parameters of the solution.

For example, the ODRIS (Ozone Data Reconstruction and Investigation System) system was created as an instrument for the study of spatial and temporal variations of ozone and revealing the factors causing these variations. Besides, the system solves the problem of reconstruction of the ozone concentration from the lidar data by means of the differential absorption technique.

One can select a few large blocks of the algorithm of the ozone reconstruction and to construct a graph of solution by the proposed scheme. The root of the graph is the node in which the initial data are selected. In addition to the ozone profile, one can extract the data on many other parameters of the atmosphere (temperature, scattering ratio), so there can be a few final nodes of the graph.

The graph constructed is the basis for application of the object-oriented technique for programming. It is logical that the principal classes are the nodes and the graph itself. The objects of the class "data" are the universal parameters for methods of the

object nodes. The class "graph" realizes the mechanism of producing the object nodes, prescribes the relations between the nodes in the required sequence (as in the initial graph) and the mechanism of calling the needed node from outside, i.e. from the interface of the program. The class "node" realizes the mechanism of calling in ascending and descending order, calls the corresponding procedure for data processing and return the data obtained according to the request.

Such an organization of the inner structure of the system has noticeable advantages both for user, by giving a chance for combining various algorithms and selecting the parameters, and for developer by making the system more "clear" and open for subsequent extension of possibilities.

D3-17

A SIMULATION OF THE TURBULENT EXCHANGE IN NEAR SURFACE LAYER OF THE ATMOSPHERE AND WATER BODIES

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Physical and optical properties of the water reservoir upper layer are significantly related with its dynamic characteristics, in particular, with the processes of turbulent exchange and wind and wave mixing. The mathematical model based on 1D approximation of turbulence (model of the second order of closure) in both media taking into account generation of the surface waves is considered To describe the interaction between boundary layers of the atmosphere and the water reservoir. Description of the wave processes is based on the solution of the kinetic equation for horizontal distribution of the frequency-wave spectrum. The issues of sewing the turbulent fluxes at the boundary are considered for correct taking into account the transmission of turbulent energy of the air stream to the water medium. The results of calculation by the model are presented.

D3-18

NUMERICAL SIMULATION OF CONVECTIVE MIXION OF THE UPPER LAYER OF WATER RESERVOIR IN AUTUMN AND WINTER

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Seasonal cooling of the water reservoir near-surface layer causes the development of penetrating convection in the form of vertical jets and descending overcooled thermics. The convective structure is described based on the vortex-resolving numerical hydrodynamic model in the 2D approximation. The non-regular field of the small-scale coherent structures is obtained. The mixing layer and the diurnal thermocline in the water reservoir are formed due to these structures. Comparison of the results of simulation with the data obtained in lake Baikal has shown their satisfactory agreement. The issue of modulation of the mechanism of formation of seasonal thermal structure of the water reservoir as whole by the short-period diurnal variation of the thermocline is studied.

D3-19

AUTOMATION OF PROGRAMMING LARGE-VOLUME LIDAR-DATA PROCESSING

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We address the issue of a fast design of applications based on the Microcal Origin program, the well-known software for scientific graphing and data analysis in the world. LabTalk is an interpreted programming language usable only within the program shell of the software package. The scripts are executed at events initiated by the user in a specified parameter range (arrangement of loops). The programming, thus, reduces to scripting a sequence of commands: create data worksheet, import data, calculate, record to a worksheet, plot results, etc. Of course, the LabTalk limitations stem from Origin itself; however, the script results can be useful for both pre-estimation of large data arrays, and as a test against which newly developed data processing algorithms can be thoroughly validated. For comparison, in developing a data processing algorithm by a traditional method (such as in Delphi environment), one has by himself to construct a calculation routine; moreover, to handle large-volume data arrays, one must supplement the calculation program with an extra module Create dynamical data array. Alternatively, in the Origin LabTalk language, it is possible, using Calculate commands, to script the standard mathematical procedures in Origin, whose last (Origin 6.0) version has, in addition, almost no limitations on the number of worksheet columns. In this report, we present examples of LabTalk scripts and Delphi routines for calculation of interlevel correlation of atmospheric parameters.

The work is supported by the Russian Fund for Fundamental Research (under grant N 99-05-64 564).

D3-20

SIMULATION OF THE TURBULENT TRANSFER AT THE DIURNAL EVOLUTION OF THE HOMOGENEOUS ATMOSPHERIC BOUNDARY LAYER

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The reliable computer forecast of the spread of pollution in the atmosphere of an industrial center using the methods and approaches of numerical simulation is impossible without ability of calculating the changing turbulent structure of the planetary boundary layer. The purpose of this paper is to perform the comparative analysis of semi-empiric models of the turbulence of different complication which is widely used for investigation of the dynamic processes in the atmospheric boundary layer. The next purpose is to select the more reliable and more effective model for numerical calculations. We used the following models: the Melpor-Yamada 1D model with the Blackdar ratio for the turbulence scale l, the two-parameter "E-eps" model in which the differential equation of transfer of the energy dissipation rate, the transport model of turbulence based on the use of the basic two-parameter "E-l" model and the equations for the Reynolds tension and turbulent fluxes of mass and heat are additionally attracted.

The considered approaches to the closure of the mean equation of motion, heat and moisture exchange were compared for the homogeneous atmospheric boundary layer without taking into account condensation and radiative income of heat. The data of observation during two days (33–35 days of the Wangara experiment), as well as the experimental data for the cases of almost neutral and stable stratification and the numerical results of other authors were used for examination. It is shown that the models of the higher level of closure are more preferable, because they better render the turbulent structure of the atmospheric boundary layer at different stratification conditions, however, they are less stable at calculations and require big calculative expenses.

The work was supported in part by Russian Foundation for Basic Researches (grant N 98-01-03017).

D3-21

APPLICATION OF COMPUTER CLUSTER FOR THE CALCULATIONS IN ICS "ATMOSPHERIC CHEMISTRY"

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The computation time in the information-computation systems (ICS) with direct on-line access to the resources is rigidly limited. If the access to supercomputers is absent, then the computation time consumption for majority of users can be decreased by methods of parallel programming with the use of computer cluster.

We present in our report the results of calculation obtained when multisequencing the problems in the ICS "Atmospheric chemistry". For various sets of chemical reactions we have built the phase patterns and dynamics of the atmospheric components concentration. The decrease of the computation time consumption is demonstrated graphically. The calculations have been conducted for computer cluster of various configurations.

D3-22

THE MATHEMATICAL MODEL OF THE ELECTRICAL AND METEOROLOGICAL CHARACTERISTICS RELATIONSHIP

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To refine the question of connectivity of the electrical and meteorological characteristics the functional or correlation dependence ought to be obtained. Solution of the problem is connected with a number of difficulties. First of all, it is an established fact of the presence of the weak correlation between the electric field strength (EFS) and such meteorological parameters as pressure, humidity, and temperature separately[1]. Secondly, EFS is not a stationary process as studies in the area of construction of the daily trend model have shown. Therefore, the classical regression model will be not correct in the sense of the square-law measure of proximity. An ascertainment of the fact of an identical dynamics of the random processes included in the model can be a possible variant of solution of the problem. In this case the multiple factor (linear or nonlinear) regression model can be constructed, which will be enough authentic within the framework of the linear measure of proximity[2]. As a result of using the nonlinear regression models the residual variance of standard deviation was reduced up to 8 % at the confidence probability of 0.67.

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D3-23

THE REGULARIZING PROPERTIES OF MEASURING THE STATE VARIABLES' DERIVATIVES IN THE PROBLEM OF ESTIMATION OF DYNAMICAL PROCESSES

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The dynamical processes can be estimated from indirect measurements. This can be done using methods of inverse problem solution based on the Tikhonov's method of regularization of initial functional.

In some papers, the regularization efficiency is increased using additional information on the derivatives of state variables.

The regularizing properties of measurements of derivatives of state variables in the task of estimating the linear dynamical system are proved by the following theorem.

T h e o r e m . For the object

$$\dot{\mathbf{x}}(t) = \mathbf{A}\mathbf{x}(t) + \mathbf{v}(t), \quad \mathbf{A} \in \mathbf{R}^n \times \mathbf{R}^n, \quad \mathbf{v}(t) \in \mathbf{V} \subset \mathbf{R}^n,$$

of equations of observations

$$\mathbf{y}(t) = \mathbf{B}\mathbf{x}_c(t) + \xi(t), \quad \mathbf{B} \in \mathbf{R}^{m+r} \times \mathbf{R}^l, \quad \xi(t) \in \Xi \subset \mathbf{R}^{m+r}$$

and of model estimates

$$\dot{\hat{\mathbf{x}}}(t) = \mathbf{A}\hat{\mathbf{x}}(t) + \mathbf{u}(t), \quad \hat{\mathbf{x}}(t_0) = \hat{\mathbf{x}}_0,$$

where $\mathbf{v}(t) \in \mathbf{V} \subset \mathbf{R}^n$ – is an unknown influence; $\mathbf{A} \in \mathbf{R}^n \times \mathbf{R}^n$ – is a generating matrix; $\mathbf{x}_c(t) \in \mathbf{R}^l$ -is a vector based on the components of the vector $\mathbf{x}(t)$, denoted as $\mathbf{x}_m(t)$, and on the components of derivatives of state variables $\dot{\mathbf{x}}(t)$, denoted as $\dot{\mathbf{x}}_r(t)$, $l \le 2n$, $m \le n$, $r \le n$; $\xi(t)$ -is the measurement noise with arbitrary statistical parameters and finite energy; $\mathbf{y}(t)$ is the compound observation vector consisting of two blocks ($\mathbf{y}_k(t)$ and $\mathbf{y}_a(t)$, with the former defined by the sate variables, and the latter by derivatives of the state variables) and related to the vector $\mathbf{x}_c(t)$ by expression with multiplication factor

$$\mathbf{B} = \begin{pmatrix} \mathbf{B}_k & 0 \\ 0 & \mathbf{B}_a \end{pmatrix}, \quad \mathbf{B}_k \in \mathbf{R}^{\mathbf{m}} \times \mathbf{R}^p \quad \mathbf{B}_a \in \mathbf{R}^r \times \mathbf{R}^{l-p};$$

$\mathbf{u}(t) \in \mathbf{U} \subset \mathbf{R}^n$ is an estimate of the influence $\mathbf{v}(t)$; and the estimate $\hat{\mathbf{x}}(t)$ minimizes the discrepancy functional, and it is found by solving Voltaire's equations of the second kind.

We present numerical results of estimating air density according to observations of the vertical motion of a trial body, which further demonstrate the regularizing properties of measurements of the derivatives of state variables when they are used to evaluate the nonlinear dynamical objects.

D3-24

GEOSIMULATION AND ASSESSMENT OF ATMOSPHERE CHEMICAL POLLUTION IMPACT

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The geoimitation approach based on the use of geoimitation model rendering the process of functioning of the object and taking into account its spatial properties is proposed in this paper for simulation of the processes of chemical pollution of the atmosphere and its impact on the environment. The geographical information systems (GIS) are used for realizing the geoimitation approach as the tools for spatial analysis and visualization of the data.

The software complex for estimating the impact of chemical pollution is developed and realized based on the geoimitation approach. The complex includes the programs for simulation of the spread of pollution in the atmosphere, determination of dangerous zones and visualization of the results of calculation on the computer map, as well as the database containing the data on enterprises in the region and the chemical substances emitted by them. The developed software complex can operate in two modes:

– prompt estimation of the consequences of failures with emission of chemical substances;

– estimation of the impact of the chemical pollution of the atmosphere on the environment at failureless job of enterprises in the region.

The models of spread of pollution in the atmosphere are considered as applied to two aforementioned modes. The peculiarities are discussed of realization of the geoimitation approach in these modes taking into account the arbitrary number of pollution sources and performing calculation both for one and a few substances emitted simultaneously.

The software used the ArcView 3.0 GIS, the program modules are constructed using the Delphi 4.0 medium, the database is created in the dBASE and Paradox formates.

D4-01

THE METHOD OF LASER–INDUCED FLUORESCENCE IN THE PROBLEMS OF INVESTIGATION OF THE PHOTOSYNTHESIS SYSTEM OF TREES

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Comparative study of the chlorophyll concentration of some trees has been carried out by traditional spectrophotometric and fluorescent laser methods. Season variations of the chlorophyll sums of coniferous and deciduous trees in spring and summer have been analyzed. Observations of the change of the chlorophyll concentration due to the withering of needle and leaves have been carried out. The experimental results have been obtained using the spectrophotometric and lidar methods for the study of season behavior of the chlorophyll concentration and distortion of the pigment complex during the withering of needle and leaves. The results of joint analysis have been shown the identity of the results obtained by principally different methods.

D4-02

MODERN DIRECTIONS OF APPLICATION OF THE CHLOROPHYLL FLUORESCENCE FOR THE STUDY OF NATURAL COMMUNITIES OF AQUATIC MICRO-PLANTS

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Fluorescence of the phytoplankton cells is used last 30 years for the study of water ecosystems as a prompt non-damaging method. The last are developed in two directions: estimation of the spatial (vertical and surface) distribution of the chlorophyll α and estimation of the primary production. Our purposes were to quantitatively determine the chlorophyll α concentration separately for each taxonomic group of aquatic plants, as well as to estimate the total rate of photosynthetic extraction of oxygen. Field and laboratory experiments, including epifluorescence analysis of separate cells of more than 40 kinds of aquatic plants have shown that when exciting the aquatic micro-plants by light of three narrow wavelength ranges with maximums at 410, 490 and 540 nm, one can differentiate the fluorescent signal at one of them and relate it to green, diatomic and blue-green aquatic plants. The cluster analysis of the results of the study of the aquatic plant cells has shown that *Chlorophyta* and *Euglenaphyta* are related to the green group, and *Bacillariphyta, Chrysophyta,* and *Xanthophyta* are related to the diatomic group. The chlorophyll concentration distribution over the taxonomic groups is limited by the noticeable variability of the fluorescence output related to the light regime and the conditions of mineral nutrition of the aquatic plants. The equation has been derived for estimating the rate of photosynthetic extraction of oxygen by the plankton aquatic plants. It variables are the relative variable fluorescence detected at the effect of a diuron inhibitor, the chlorophyll α concentration, the intensity of light at the prescribed horizontal level. The equation takes into account the light dependence of the oxygen extraction rate and gives the results comparable with the phial and amperemetric methods.

D4-03

INTERCALIBRATION OF TWO METHODS OF QUANTITATIVE MEASUREMENTS OF CO_2 EMISSION FROM THE PEAT

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The problem of CO_2 balance is a basic in the biosphere study and in the prediction of consequences of the global climate change due to anthropogenous impacts. The growing mires are the unique ecosystems among the terrestrial biosystems capable to fix the atmospheric CO_2 for a long period. The CO_2 emission from peatlands into the atmosphere is caused by mineralization processes of organic substances taking place due to drainage. The quantity of carbon dioxide emission from the peatland or from the peat deposits surface is an integral indicator of the transforming processes intensity in the peat. Different physical-chemical methods are used in the CO_2-gas-analysis. The aim of this work is a comparison of the hemosorption and optoacoustic gas-analysis methods. The outlines of the methods and their characteristics is also presented. The intercalibration was carried out under maximum possible identical conditions of the experiment. The CO_2 concentration and CO_2 emission kinetics at mineralization process of peat were measured simultaneously by both methods. It was shown that the results are in good agreement.

The work is partly suppoted by RFBR (the projects N 99-05-64233, 98-05-64068).

D4-04

CHLOROPHYLL FLUORESCENCE AS APPLIED TO BIOINDICATION OF THE ATMOSPHERIC POLLUTION

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The thermal stress method is applied for revealing the hidden damages of photosynthetic system of pine (Pinus sylvestris L.) needle characteristics of the weak technogenic pollution of the atmosphere. The ratio of the slow fluorescence (SF) intensity before and after thermal impact was used for estimation of thermal stability of the needle. It is revealed that in winter and spring the SF parameters of the needle of trees in polluted areas decrease by several times after a dose of heating, while in clear areas they practically do not change.

Investigation of seasonal dynamics of SF of needle and the depth of winter peace of pine trees growing in the areas with different level of air pollution has shown that the trees from the areas with high level of pollution pass to the winter peace state later than that from conventionally clear areas. Under laboratory conditions, needle of pines from polluted areas turns out from the winter peace state more quickly. It is supposed that the observed «draining» of trees in the areas with high level of pollution can be a consequence of their partial pass to the winter peace state.

Thus, owing to the applied fluorescent parameters, one can more completely characterize the state of coniferous trees at technogenic influence, and to perform the bioindicative estimation of air medium on this basis. Both techniques have been successfully applied when investigating the state of coniferous trees in Tomsk and Gorno–Altaisk.

D4-05

THE CONTROL AND DIAGNOSTICS OF FOREST STATE BY THE INFRARED METHOD

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The problems of remote monitoring of structural and thermalphysic characteristics of a forest by an infrared method and the capabilities of forest state diagnostics based on processing and analysis of instrumental measurement results are considered. The diagnostic technique of a forest state is based on the thorough knowledge of features of the infrared fields of vegetative objects at different conditions and on the relations between thermalphysic characteristics and state parameters of a forest and surroundings.

The procedures of remote measurements in a forest by the portable pyrometer are developed for the brightness temperature of objects located at a distance up to 100 meters, different segments of extended objects at telescope scanning on object surface, temperature profiles of single tree and temperature fields in a forests at telescope scanning along definite trajectory. The results of experimental researches of thermalphysic characteristics of mixed forests at flat and mountain taiga forests at Altai mountains carried out with the help of the portable pyrometer (DHS - 14 type) have demonstrated the efficiency of remote monitoring of spatial organization of tree plantations, plant structures, glades, tree top density, estimation of pathology (stressen tree definition) and ecological disturbance. The analysis of thermal portraits of trees and thermal profiles of stand of trees allows us to determine geometry and size of tops and density of foliage and to evaluate a forest state.

D4-06

UV CLIMATE IN THE CONDITIONS OF ANTHROPOGENIC ATMOSPHERIC CONTAMINATION

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Anthropogenic pollution of the atmosphere distorts the natural equilibrium in the biosphere by not only direct physical–chemical relations but also indirectly by the climate change. The majority of unhealthy ingredients in the atmosphere have the strongest optical activity in the UV spectral range, distorting both the microstructure of the natural radiation and the general state of climate. Besides, the carcinogenic effect of UV radiation is added in the polluted medium by photochemical processes, when the radiation of «incarcinogenic» spectral ranges favors synthesis of the carcinogens – photooxidants. The last effect is especially observed in transport exhausts in summer. However, the total ecological effect of the sum of unhealthy exhausts is not only the direct toxic effect on the animate nature, but also production of the stable "deficit" of biologically active natural "ultraviolet".

The complex mechanism of interaction does not make it possible unambiguously solve all problems of transformation of natural radiation in the environment by theoretical and model calculation methods, especially if the environment has been polluted. The results of observation of the incident UV radiation by means of the "Rigel" spectrometer were used for this purpose. The total deficit of the UV radiation in Kazan region in spring and summer vegetation periods varies from 14 to 38%. We have succeeded in selecting the anthropogenic component of the "deficit" only in winter sunny days at the change of wind

direction from south to north. According to our estimates, the unhealthy exhausts in the city of Kazan absorb from 9 to 43% of the biologically active UV radiation.

D4-07

MONITORING OF NATURAL UV RADIATION AND I-TS EFFECT ON THE ENVIRONMENT

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Energy in the ultraviolet (UV) spectral range accounts for no more than 10% of the total flux of solar radiation. In spite of small fraction, UV radiation significantly affects the vital activity of all forms of vegetation and animals. The most "rigid" quanta of this radiation form a "biological shield" – the ozonosphere that fully absorbs the vitacide radiation ($\lambda < 300$ nm). Only the quanta reaching the Earth surface determine the existing ecological equilibrium in the nature.

UV radiation affects the animate nature selectively. The quanta of this radiation have bactericide and fungicide effect. It has therapeutic and tonic effect on a man, affects the metabolism, breath, circulation of the blood, endocrine glands, enhances the hemoglobin, favor formation of histamine and vitamin D. However, the long–term irradiation causes aging of the skin, leads to solar burns, cancer of skin and melanoma. Solar radiation activates vegetation, accelerates the photosynthesis and producing of vitamins. UV climate is one of determining factors of the regional ecology.

The original spectrometric complex "Rigel" has been created for direct measurements of the UV radiation and mounted at the stationary post. The technique of measurement makes it possible to determine the daily doses of bactericide, fungicide, visual and sunburn radiation. Monthly, annual and the "deficit" of each component was determined numerically. In calm meteorological situation one can determine the additional thickness of the ozone layer as well as observe UV splashes at the Sun.

D4-08

ON MATHEMATICAL SIMULATION OF PRODUCTIVITY OF FOREST PHYTOCENOSIS AND SOME ISSUES OF THEIR OPTICAL DIAGNOSTICS

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The general mathematical model of forest fire was proposed in [1, 2]. Numerous calculations of the spread of forest fires were carried out based on it [2]. Comparison of the results of calculations with experimental data has shown that the model adequately describes the spread of upper and lower forest fires. The system of partial-derivative equations for prediction of interaction of forest vegetation with the atmosphere was constructed in [3] based on the mass and heat transfer model proposed in [1, 2] using the results of [4, 5]. These equations express the laws of conservation of mass, motion quantity and energy in the multiphase reacting medium - forest phytocenosis. This paper refined the aforementioned system of equations. Besides, the question is discussed of the optical diagnostics of the state of forest phytocenosis using the derived system of equations and the A.N. Tikhonov method for solving the inverse problems of mathematical physics.

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D4-09

THE ESTIMATING OF CONIFEROUS TREES STATE IN TOMSK WITH THE FLUORESCENCE METHODS

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Modern fluorescence methods make it possible to promptly estimate the state of trees that is very urgent in urban conditions.

To study the state of pines and firs in Tomsk, four test sites strongly different in the atmospheric pollution level were selected in the city, and two sites were selected in rural area. The fluorescent parameters of the needle were recorded by the "Photon-5" and "photon-7-1" fluorimeters developed at the Department of Ecology of Krasnoyarsk State university.

The exit of he plants out of the winter repose state was assessed by means of recording the thermoinduces changes of the zero level of chlorophyll fluorescence (TIZLF). Investigations have shown that the plants in the areas with higher level of pollution exit from the repose state more quickly than the plants which are in the more clear areas of the city. Then, firs under laboratory conditions exit from the repose state more quickly than pines. The difference between the check site and the strongly polluted site in Tomsk is more significant for firs, that confirms the higher sensitivity of firs to atmospheric pollution in comparison with pines. The analysis of the indices of slow fluorescence of the needle chlorophyll was carried out simultaneously.

Thus, the worsening of the physiological state of coniferous plants growing in the central part of the city was revealed by means of the fluorescence method.

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